KNOWLEDGE
AN ILLUSTRATED MAGAZINE OF SCIENCE, LITERATURE & ART.
Founded by RICHARD A. PROCTOR.

LONDON: NOVEMBER 1, 1899.

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THE MYCETOZOA, AND SOME QUESTIONS WHICH THEY SUGGEST.—VI.

By the Right Hon. Sir EDWARD FRY, D.C.L., LL.D., F.R.S., and AGNES FRY.

THE INDIVIDUAL AND THE GENERATION.—But it is time to return from the long digression into which we have been led by the unicellular plants. If we consider ourselves or any other higher organism, whether animal or vegetable, and ask what is the individual and what is the generation, we feel at first quite able to reply. We know that the answers to these questions, when we seek to pursue the enquiry to the bottom, involve other profound questions, perhaps, insoluble difficulties, but on the surface the answers are easy.

If now we turn to the myxies and ask what is the individual, the answer seems attended with no small difficulty. In the swarm spore stage each separate protoplast is the individual; each is capable of separate motion, of digestion, and of multiplication. If we turn to the plasmodium stage, the individual appears to be the entire plasmodium, built up as it has been by the union of a great number of protoplasts, and not always the descendants of the same parents; if we take the sporangium stage, and consider especially those cases in which each sporangium stands on its own hypothallus, separated from the hypothallus of its neighbours, the sporangium seems to represent the individual. The life-circle of the myxie thus exhibits a curious alternation of individualism and collectivism—an harmonious solution of the problem raised by the claims of the two principles which are found in conflict in other organisms and states of society.

DEATH AND REPRODUCTION.—We know that of late years many interesting theories and questions have been propounded in relation to the great fact of Death, and that the entrance of Death into the great chain of organic life has been watched and studied.

One view, to which Professor Weismann has given great prominence, is that unicellular organisms possess an unending duration, or, in other words, that though susceptible of death by external force—as, *e.g.*, by fire—there is no natural death, but on the contrary a potential immortality. He considers death, therefore, to have come in with the multicellular organisms, and to take place, as he says, "because a worn-out tissue cannot for ever renew itself, and because a capacity for increase by means of cell division is not everlasting but finite."

Another view put forward (not by Weismann but by Götte) holds that death is always connected with reproduction, and is a consequence of the latter in the lower animals.

Lastly may be noticed another view, also propounded by Götte, that the first form of death is to be found in the phenomenon known as encystment, which occurs when an organism which has been alive and exhibiting the phenomena of motion becomes stationary, develops a cyst or coat around it, and after a period of rest and suspended animation again revives when the favouring circumstances occur.

We thus state some of the views with regard to death because we think that it will be found that the life-history of the myxies throws some light upon them.

Let us, however, first make these remarks: that in the higher organisms we know of death in two forms, the death of a part cast-off, as when we shed a hair or lose a tooth, or as when a tree casts off its dead leaves; and, secondly, the death which affects the whole organism; and further that reproduction is in a great majority of the higher organisms accompanied by the casting off of some parts of the organism which have been devoted to the nutrition and protection of the young offspring. In plants we know how the floral envelopes drop off, and how the seed vessels are allowed to fall and decay when their duty is done; and corresponding phenomena exist in the animal world.

When the plasmodium of the myxie has differentiated itself into the hypothallus and the sporangia, and these have sent forth the spores, how are we to regard the events which have happened? Is the true view that a parent organism has died; that the empty sporangium and the stalk, and the capillitium and the hypothallus which are left behind to decay are the dead body of the parent, and that the spores represent the new generation?

If this be the true view, and there seems much probability in it, then we have clearly before us an unicellular organism of the simplest kind, which exhibits the phenomenon of death, and we cannot say with Weismann that it is with the multicellular organisms that death for the first time occurs.

On this assumption it further follows that we have in

the myxies an instance of the close association of death with reproduction; and we are reminded of the analogous cases of the mayfly and the butterfly, which die after laying their eggs, and of the death of the male bee after pairing.

The other view of the facts to which we have referred is that the throwing off of the sporangium and the capillitium, and the shells of the spores, is not the death of the whole parent organism, but the partial death only which occurs when the parts which have become useless are cast off and allowed to die, and in this view there is in the cycle of the myxie's life neither death nor generation, but an everlasting life; the same protoplasm would be thought of as going on in an eternal round of life, subject only to accretions and to losses. True it would be that the shell of the spore, the coats and foot of the sporangium, and the capillitium which it contains, have been thrown aside and perish; but the residue of the protoplasm seems to pass from swarm spores into plasmodium, from plasmodium to swarm spores, and so on in a perpetual round. The swarm spores thus appear not as emanations from the parent but as the parent itself, and the new generation and the old are but one person (if personality may here be spoken of). If we think of death we search without success for the moment of its occurrence, and we look in vain for the dead body.

Whether of these two views be the more reasonable it may be hard to decide. However that may be, it is certain that there are unicellular bodies, such as the Diatoms, in respect of which Weismann has so forcibly shown that death cannot be thought of as a normal event. Thus out of the depths and first rudiments of organic life there crops up a suggestion of that immortality which is the hope and aspiration of its very highest members.

Then with regard to encystment. We have seen that this occurs in two forms in the life-history of the myxies. We have found that the single swarm spore may be encysted and is then known as a microcyst, and that from this condition it may be awakened and recalled to its activity as a swarm spore, and we have found also that, in the form of sclerotium, the whole plasmodium may become quite dry and hard as an aggregation of cysts, and thus be reduced to a condition of suspended vitality, but from this also it may be aroused to its former powers of movement and life as a plasmodium. In neither of these cases do we find encystment to be associated with death, nor with reproduction. "The essential characteristic of encystment," says Weismann, "is a simple process of rejuvenescence without multiplication."

The length of time during which animation can be suspended in the case of plasmodia is very remarkable. De Bary found a plasmodium of *Didymium serpula* to move after seven months' desiccation; and a case is cited by him of a plasmodium which after twenty-five years' residence in an herbarium began, after four or five days' immersion in water, to develop as a beautiful network.

Relations of the Group.—The proper position of the myxies in the world of organized beings is a subject on which there has been and still is a great difference of opinion. So profound is the difficulty of the question whether they are animals or vegetables that one of the most careful students of their nature has declared that its solution "depends rather on the general philosophic position of the observer than on facts."

Those authors who place the myxies in the animal kingdom have generally attached most importance to the swarm spore and plasmodium stages of their existence, and have insisted on their likeness to the protozoa; the advocates of their vegetable character have mainly dwelt on their method of reproduction—on their sporangia and their spores.

But even assuming them to be vegetables, there remains the question where they are to take their place in that realm of Nature. They were placed among the fungi by Fries, but with a lively consciousness of how entirely they differed from all the other members of the class. "Vegetatio maxime singularis et a reliquorum fungorum prorsus diversa," he says of this group. The fungi seem as a natural group to be well characterized by a prothallus constituted of hyphæ—generally multicellular—whereas the myxies are represented in that stage by the strange plasmodium of which we have said so much.

Attempts have been made to show that different sections of the myxies correspond with different sections of fungi: the common myxies being treated as of the Gasteromycetic type; the *Dictyostelium* as of the Mucorine type; and, according to some writers, the *Ceratomyxa mucida* as of the Hydnum type and the *Ceratomyxa porioides* of the Polyporus type; and from this supposed correspondence of type it has been suggested as probable that other types of fungi will be found to be represented amongst myxies, and that so we shall have two parallel series of fungi; the difference in each case being that the one is characterized by a mycelium of hyphæ, and the other by a plasmodium. This view appears to us to be fanciful, and to slur the really broad line of distinction between fungi and myxies. More rational would seem to be the view put forward by one of the latest writers on classification, who has formed of these little organisms one of the four primary divisions of the vegetable kingdom, and made for them a place of equal rank with the whole of the phanerogamous plants; so distinct a position scarcely seems excessive to mark the singularity of their structure and life-history. In fact, one of the many interesting points about this group of organisms is the extent to which they stand alone; the difficulty of finding any other creatures to which they stand in the relation either of descendants or ancestors. "The mycetozoa," says De Bary, "show only a slight agreement, either in the general course of their development, or in the characteristic features of its separate stages, with organisms which are of undoubted vegetable origin, whether they be fungi or plants other than fungi; the agreement, with the exception of the few cases in which cellulose makes its appearance, is common to phenomena which are common to all organised bodies."

We are much impressed with the notion that the position of the myxie will be found to vary according as the one or the other stage of their existence is held to have the highest classificatory value. We therefore propose to consider what relations they exhibit in these various stages of their life-history.

SHELLS AS ORNAMENTS, IMPLEMENTS, AND ARTICLES OF TRADE.

By R. Lydekker.

From the intrinsic beauty of their form and coloration, coupled with their almost imperishable nature, the shells of numerous kinds of molluscs have been employed from the earliest times by aboriginal tribes in all parts of the world as articles of personal adornment. Others, again, are suitable as implements for culinary and kindred purposes; while a few have been selected as convenient media for exchange. Not only are entire shells, either singly or strung together, employed as personal decorations, but in many instances the shells are cut or ground, either into bangles, or into

pieces capable of being more conveniently strung together than are entire specimens. In later times, shell-cameos have commanded well-deserved admiration; while the beauty and utility of mother-of-pearl has been recognised from time immemorial. Since a separate article has been devoted to the latter substance, attention may be restricted in the present communication to the uses of shells of other descriptions. So numerous, however, are their applications, and so great is the number of species concerned, that only a very few of the more striking examples of each type of use can be even mentioned. With regard to the volume of the trade in shells, which is mainly carried on in Britain, it is to be regretted that precise statistics are not forthcoming. In the Board of Trade returns, the item "shells" is taken to include both mother-of-pearl and tortoiseshell, so that the figures convey little real information, especially as they relate to value alone. In this wide sense, the declared value of the "shells" imported into the United Kingdom during 1897 was five hundred and eighty-five thousand, five hundred and fifty-three pounds. Whatever be its precise amount, it may be taken for granted that the British trade in shells, other than mother-of-pearl and tortoiseshell, is of very considerable volume.

Evidence of the early development of the taste for shells as articles of personal adornment is afforded by discoveries made among the remains of the prehistoric inhabitants of central France. Living at a distance from the sea, these primitive people were unable to procure recent shells, and accordingly had recourse to some of the fossil species so abundant in the neighbouring tertiary deposits. Although deprived of their colours, these fossil shells, which have been perforated for stringing into necklaces by the cave-dwellers, still retain their original polish, and are thus objects of considerable beauty. Among modern aborigines the taste for shell ornament seems to have attained its highest development among the Melanesians and Papuans of the South Seas. In Fiji and Tonga the chiefs wore the lovely orange cowry as a special badge of rank; while the large egg-cowry (*Ovula ovum*) is much favoured by many Melanesian tribes, and especially the Papuans. Not content with their own shells, these latter savages imported those of a species of *Struthiolaria* (a distant relative of our whelk) from New Zealand; these they ground down till little except the mouth remained, in which condition they were strung together into necklaces. Sections of the melon-volute (*Melo*) were also worn as part of a breast decoration, while shells of a large *Turbo* and *Conus* were ground down into bangles or sheaths for the upper arm. A coronet made of a species of periwinkle (*Littorina*) was in use among the Fijians; and necklaces and coronets composed of *Naticas*, top-shells, etc., were worn by many of the islanders of the South Pacific, especially those of the Ellice group and of Flinders' Island. Very curious is a necklace in the writer's possession, which probably came from the Marquesas; it is shown in the accompanying figure, with an entire shell of *Conus virgo* in the centre.* The necklace is formed of the tops of thirty-one specimens of that shell, and as these were doubtless reduced to their present condition by grinding, the labour expended on this ornament must have been very great. Large specimens of the same white cone were cut in two and worn as neck-ornaments in Samoa. Very elaborate are the tall coronets of black and white shell formerly worn by the chiefs in the Marquesas. These consisted of upright pieces of thin curved shell, about two inches in height and somewhat less in width, apparently belonging to some kind of bivalve; every other one was stained black, and all were fastened together by a circle of cord. Long necklaces of money cowries were often worn by some South Sea Islanders; the back of each shell being ground down to display the inner whorls. We have likewise seen a belt from India ornamented with a number of these cowries sewn on it with their mouths exposed. Beads made from

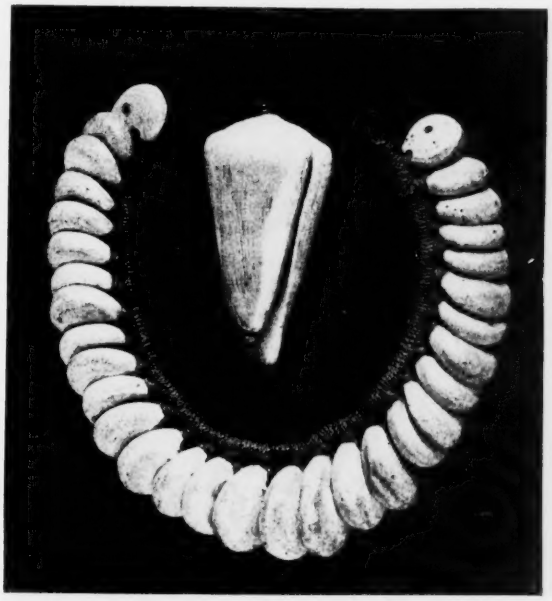

FIG. 1.—Necklace made from the Virgin Cone, with an entire specimen of the Shell.

the crimson lip of a large *Strombus* are also worn as necklaces by the Papuans; while nose-ornaments are formed by grinding down segments from the horned helmet-shell (*Cassis cornuta*). A fillet on the forehead bearing a single specimen of the warty egg-cowry (*Ovula verrucosa*) distinguishes the chief of a Papuan village; while the ears of many of the same race are often decorated with a piece of bivalve shell, through a hole in which locks of hair are passed. In Samoa an elaborate fillet was made from the pearly inner whorls of a *Nautilus* imported from New Zealand and Australia. The brilliantly polished green *Trochus iris*, the so-called *Elenchus*, was used as an ear-drop by the Maories.

Equally partial to shell-ornaments were the aboriginal inhabitants of America. In South America the cloaks of the women were adorned with various land and fresh-water shells, such as *Ampularia* and *Bulimulus*; while large species of *Bulimus* were worn on the breast connected with chains of other substances. Some North American tribes used tooth-shells (*Dentalium*) to decorate the nose and ears; while others, as those of the Salt Lake district, made necklaces of various small univalves belonging to the genera *Oliva* and *Marginella*. In these instances the shells were used entire; but many other kinds were ground down either into disks or cylindrical beads, which after being strung together, were employed as money under the name of wampum. Ordinary cylindrical wampum was made from the bivalve shell of the common clam (*Venus mercenaria*); some of the beads being of the white colour of the shell, while others, which bore a higher value, were cut from the purple margin. Another kind of wampum

* No specimen of this type of necklace exists in the British Museum.

was made from a reversed univalve shell (*Fulgur perversus*), allied to the Indian chank-shell; and a third description from a species of *Olivella*. Large and much valued cylindrical beads (some of between two and three inches in length, and of the shape of a cigar) were likewise cut with great labour from the pink core, or columella, of the queen conch (*Strombus gigas*). Not only was wampum employed as a means of exchange, but it was also worn as a personal adornment; while by a careful arrangement of the beads according to size, shape, and colour, it also served the purpose of an historical record, and to convey messages. On the invasion of the east coast of America (to which the use of wampum was restricted) by Europeans, shell beads of various descriptions were soon introduced, and the value of wampum discredited.

In its monetary aspect, wampum naturally leads on to the consideration of those shells employed as media of exchange in their natural condition. In north-western America such money took the form of a species of *Dentalium*, the hollow, tusk-like shells of which were threaded on strings, whose value depended on the number and condition of the specimens they bore. In certain islands of the South Pacific a species of nerite served as currency; and in the New Hebrides, sandal-wood for the China market was purchased with a species of egg-cowry (*Ovula angulosa*). The shell which has long served in the capacity of money throughout many countries is, however, the well-known white money-cowry (*Cypræa moneta*); the nearly allied ring-cowry (*C. annulus*) being also employed to a considerable extent. A native of the Pacific and Eastern Seas, the money-cowry has from time immemorial been employed as the lowest medium of exchange in India, where even at the present day a few grains of parched corn can be obtained in return for one of these shells. But it is also very largely employed among the natives of the west coast of Africa. To supply these districts, cowries are imported from the East into Liverpool, whence they are again shipped to their destination. Thirty years ago the annual import of money-cowries into Lagos ranged between fifty thousand and sixty-five thousand hundredweights, but of late years the trade has fallen very greatly. From the west coast, cowries penetrate far into the interior of Africa, reaching even to the Sudan, where they are employed to decorate the conical caps of the inhabitants of the Bahr-el-Ghazal valley. On the west coast their value ranges between ten and fifteen pence per thousand.

Allusion to necklaces of money-cowries has been already made; and it should be added that throughout India these shells are largely employed to decorate the trappings of horses, camels, elephants, etc., while they are worn on the dress by Binjari women. In the British Army the bridles of the Tenth Hussars are ornamented with money-cowries. By the Dyaks a somewhat ghastly use is made of these shells, who stick one in each eye-socket of the skulls of their slain enemies.

Returning for a moment to the use of shells as personal ornaments, it may be mentioned that bracelets are occasionally made from the prettily marked zigzag cowry (*Cypræa undata*), a number of which are mounted side by side, with their long diameters parallel. The flattened and circular spiral shells of the genus *Rotella* are mounted both as bracelets and as studs. Elegant bracelets are likewise made from the polished green opercula of certain kinds of *Turbo*, small specimens of the same being employed for studs. Bracelets and brooches made of shell-cameos are noticed later.

The most important industry connected with shells as articles of personal adornment would seem to be the cutting of bangles from the chank-shell (*Turbinella rapa*), which is carried on at Tuticorin. This shell, which is sacred to Vishnu, and figures on the coins and postage-stamps of Travancore, is a large and heavy spiral univalve, with a long siphon and three bold ridges on the core. When the epidermis is removed, the shell is white and porcellanous. Occasionally reversed, or sinistral, specimens are met, which are highly prized. One such obtained in 1887 fetched 700 rupees; and a second specimen has been subsequently dredged. The chief trade is done in green, or living chanks, which are dredged in from one to three fathoms of water off the coasts of Ceylon and Southern India, the white, or dead chanks, cast on the shore by the waves being of comparatively little value. Formerly the export of chanks from Tuticorin to Madras and Calcutta averaged something like half a million annually, with an estimated value of from ten thousand pounds to fifteen thousand pounds; while a rent of four thousand pounds a year was paid for the right of fishing in Ceylon. Of late years, however, the trade has decreased, the number of shells obtained during the winter of 1885-86 being three hundred and thirty-two thousand, with a value of nearly twenty-four thousand rupees. The great bulk of these shells go to Dacca, where they are sliced into bangles and anklets for Hindu women by means of a primitive saw shaped somewhat like a cheese-cutter. Many of these sankha, as they are called, are of a complex structure, having a movable segment which can be fixed by means of pins; and they are frequently decorated with tinsel and coloured glass. The practice of leaving the sankha on the body during cremation renders the demand for these articles constant.

But it is not only as bracelets and anklets that chanks are employed; in the uncut condition they are mounted in metal and bored to form trumpets, while they are also sometimes used as oil-vessels in Hindu temples. In Dacca they are also stated to be employed for glazing calico, and in Nepal for polishing paper. Neither are bangles cut from these shells alone, as they are made in Queensland from the pearl-oyster, and in the Marquesas from the large top shell (*Trochus niloticus*), while mention has already been made of those cut from a *Turbo* in Papua.

The employment of the valves of a large scallop (*Pecten*) as a badge by pilgrims is familiar to all. In addition to their use as personal ornaments and decoration to trappings, shells are employed by aboriginal tribes for other decorative purposes. In the Solomon Islands, for instance, canoes are ornamented with rows of univalves of the genus *Natica*, while cowries decorate the shields of the same people. The large egg-cowry (*Ovula ovum*), in addition to its use as a personal ornament, is attached to the drums of the Papuans, and the eroded cowry (*C. erosa*) to their drinking vessels.

With the chief exceptions of wampum and the money-cowry, the chief uses of shells noticed above have been as articles of luxury rather than of real use. In Fiji, however, the Surinam-toad cowry (*Cypræa mauritiana*), together with a large species of *Turbo*, is employed by the natives for sinking their nets. A bisected tiger-cowry (*C. tigris*), enclosing a stone, and decorated with a pair of bright-coloured olives (*Oliva*), is found to form an attractive bait for cuttles in the same islands; while in the Tonga group a nearly similar bait is made by fastening several pieces from the back of the same species of cowry around a core of hard wood. In all the Pacific Islands, fish-hooks, which in some cases appear to act also as artificial baits, are cut from ear-shells (*Haliotis*), as well as from wing-mussels (*Avicula*), additional strength being sometimes given by a

splint made from the core of the nutmeg-cowry (*C. arabica*). In the Andaman Islands, according to the late Dr. V. Ball, the natives employ a bivalve (*Cyrene*) as a knife; and the Fijians make knives and scrapers from the pearl-oyster. In Woodlark Island, small axe-heads are ground out of a species of auger-shell (*Terebra*), larger implements of the same nature being made in Fiji from giant clam (*Tridacna gigas*). Cubical blocks cut out from the same shell were used in the Tonga group as missiles in war. As receptacles for holy water in churches, large valves of the aforesaid species, which may measure as much as a yard in diameter, have long been in use. As a substitute for glass in windows, the thin flat valves of the glass-oyster (*Placuna placenta*) have been employed for ages among the Chinese. As spoons and balers, the shells of many species, both bivalved and univalved, are employed in different parts of the world. Among them, it may be mentioned that a melon-volute (*Melo diadema*) is used in Papua to bale the water from canoes; while in the Moluccas neat spoons of various sizes are cut from the outer side of another species of the same genus and mounted with horn or bone handles. In West Africa the great snail shells of the genus *Achatina* are used as spoons; and in some countries melon-volutes are made into lamps. Valves of marine and freshwater mussels are used by the Papuans to peel yams; and the employment of mussel-shells to hold gold and silver paint is well-known. As trumpets, in addition to the Indian chank, reference may be made to the large triton (*Triton tritonis*) and the horned helmet-shell (*Cassis cornuta*) of the South Pacific, as well as to a species of the allied genus *Ranella*. In the West Indies the queen-conch is used for this purpose. A hole is drilled in one of the smaller whorls of the spire of these shells to serve as a mouthpiece. In some of the Malay countries table ornaments are made from nautilus shells by cutting open the central chambers; while the entire shells may be used for drinking cups, and are sometimes mounted in Europe as flower vases or dessert dishes. Finally, mention may be made of the Fijian practice of carving imitations of the

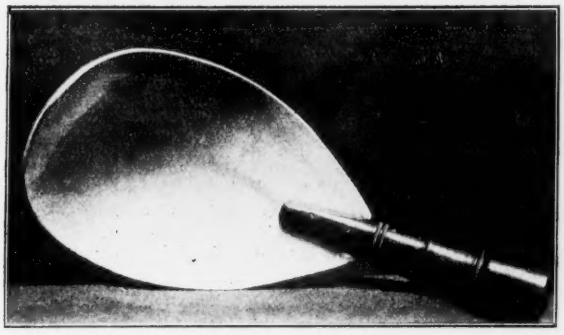

FIG. 2.—Spoon made from the Shell of a Melon-volute.

orange-cowry and the mole-cowry out of sperm-whale teeth.

Turning to the uses of shells, other than mother-of-pearl, among civilised nations, we find the cutting of shell-cameos forming an important industry; although, owing to large brooches being out of fashion, this trade is probably much smaller than in past years. In 1870 the value of the shell cameos imported into Great Britain was three thousand four hundred and forty-five pounds. The favourite shells for large cameos are the black helmet (*Cassis madagascariensis*) from the West Indies, in which the white cameo shows up on a claret ground; the horned helmet (*C. cornuta*) of the South Pacific, which has an orange ground; the scarlet bull's-mouth helmet (*C. rufa*), imported from India and Ceylon, which shows a red or sardonyx ground; and the West Indian queen conch (*Strombus gigas*), with a beautiful pink ground. Of these, the horned helmet is the least satisfactory, as the layers are apt to split; the best being the black helmet, from which a number of cameos can be cut. Those cut from the queen conch lose their colour. The cameos may either be left in the shell, or cut out separately, when they are mounted as brooches, bracelets, studs, etc. Occasionally they are cut in the tiger cowry, when a purple ground is obtained.

In addition to its employment for cameo-cutting, the queen conch is largely imported for other purposes. It is frequently exhibited as an ornamental shell, especially in the London milk-shops; but its chief use is for grinding into powder and mixing with the other constituents of the finer kinds of porcelain. In the year 1850 no less than three hundred thousand of these shells were imported from the Bahamas into Liverpool. Shells also form the finest quality of lime for building and cement; and such lime may be made either from the accumulations of shells on beaches, or by collecting shells for the purpose. In the neighbourhood of the Salt Lake, some distance from Calcutta, two large conical blackish univalves, belonging to the genera *Potamides* and *Telescopium*, are collected from the brackish water in enormous quantities for this purpose. The huge heaps of these molluscs are left to fester in the sun till the soft parts are decayed; and the smell emitted during this process can be better imagined than described. Money-cowries have been employed to form the enamel used in watch and clock faces.

Although the finished products can scarcely be regarded as occupying a very high position when judged by the artistic standard, the manufacture of shell-covered boxes and fancy articles occupies a very important position in the British shell-trade. A large percentage of the shells thus used are collected on the British coasts, and are known in the trade as grotto-shells. Both in this country and in Japan, shells are also employed to make artificial flowers. In the British manufacture large flowers, such as tulips and roses, are those generally selected for imitation; but the Japanese attempt smaller and more delicate blooms. Elegant specimens of their work may be seen in the shell-gallery at the Natural History Museum. Then, again, there is a large trade in various descriptions of common shells, such as small scallops, cockles, polished mussels, whelks, etc., which are mounted with velvet and silk to form pin-cushions, needle-books, purses, and other fancy articles. A number of species of shells are polished and sold as ornaments, as are many of the larger and handsomer kinds in their natural condition. These are known in the trade as fancy shells; and when to these are added the hosts of less common species which pass through the dealer's hands previous to finding a place in the cabinet of the shell collector, it is evident that the total traffic in these beautiful objects must be very large indeed. It seems, however, that the trade is by no means in such a flourishing condition as it was some twenty or thirty years ago; the popular taste for shells, either as natural history specimens, as ornaments, or in the form of shell-boxes, having very appreciably declined.

It may be added that while the majority of shells claim our admiration, both from their form and their colouring, mother-of-pearl owes its position solely to its unrivalled lustre. Another lustrous substance obtained from molluscs is the so-called shell-opal, formed by the fossilized remains of ammonites.

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ELECTRICITY AS AN EXACT SCIENCE.

By Howard B. Little.

VI.—The Relation of Modern Electrical Practice to its History, its Units, and its Reasoning.

HISTORY, units, and reason are the three essentials to the existence of every exact science. Accidental discovery or observation lays the foundation of history by the recognition of certain facts. The application of reason to these facts tends to the increase of their number, till ultimately the history is sufficiently far advanced, and the reason is sufficiently well directed to produce a series of units, which must, in time, be brought together and arranged in some definite system, and the said system, while rendering as many as possible of its constituents absolute, should also bring about their mutual dependence.

The more exact the science, the greater is its dependence on its history, the more complete its system of absolute units, and the more logically, or mathematically, sound its reasoning.

If it be correct to consider the fulfilment of all the above conditions as essential to the existence of any exact science, and if the above conditions require no amplification, we are furnished with the complete series of tests required for the substantiation of the claim suggested by the main heading of these papers.

Before dealing categorically with these tests it may be well to glance at another proposition:—The ultimate object of the pursuit of scientific truth should be the leading up to some useful practice. Yet, the pursuit is under no circumstances to be abandoned, if only because practice never does make perfect.

But will electrical science pass successfully through the entire series of tests as suggested above?

In answer to this, permit, for the moment, the asking of another question: In which does it fail? The answer is inevitable—In none. But bear with me one moment yet. I wish to press this point, and yet make no assumption which cannot be justified. Assuming the accuracy and completeness of these tests, in the light of the last answer, electrical science would appear to be the very perfection of science. Yet, alas, we are compelled to make this assertion with one important reservation, indicated by the words, "according to our present knowledge."

The idiot's reasoning is undoubtedly, according to his present knowledge, the perfection of logical reasoning. Yet, while freely admitting the truth of this, our appeal is made to the majority, and so far as our discussion has now taken us, we are in this position, we rely upon the verdict of the majority to prevent our falling into mistakes such as could only be termed idiotic. In other words then, our reservation may be expressed by the simple statement that a majority is not always infallible.

Obviously all this implies that our knowledge must be increased, so that future generations may have more history to refer to. It may be urged that the favourable verdict of the majority is taken for granted here. So it is, but with the best justification that can be found, which is that, daily, electrical undertakings are being entered upon, and information from the past (history), units, and reason, as already alluded to, render the carrying out of such undertakings possible.

But now to consider the application of the tests individually. Is modern electrical practice really dependent on its history? Yes, because, apart from the details of observed fact handed down to us, we find that a mere fable, coming to us from the "dark ages," was sufficient to turn the thoughts of many into a channel which ultimately led to the evolution of modern telegraphy.

It will be noted that very frequent reference has been made to telegraphy throughout these papers; this is partly because that branch of the science does furnish a number of very striking object lessons, and partly because, in a limited space, a more striking claim can be worked out if it be based, as far as convenient, upon a single branch.

Is modern electrical practice dependent on its units? No. The value of every unit might be doubled, halved, or multiplied by any arbitrarily chosen number or fraction. Yet, whatever system of units be adopted, modern practice requires such units; and, history leads us to assert that the existing system is the most simple and easily dealt with, therefore the one most in conformity with logical reason. Added to this, what other scientific or commercial measurement is established upon such a basis that the consumer is only expected to pay for that effect which is useful to him?

It seems absurd to put the third test: Is modern electrical practice dependent upon electrical reasoning? Let it suffice to assert that the electrician whose brain is not furnished with a just appreciation of logical argument and an equally just appreciation of mathematical accuracy of thought and practice, besides having these mental weapons so disposed that they are ever ready to hand, had better pause, and consider his equipment before entering upon the struggle perpetually raging in the "excited field."

And, finally, if I have in any way succeeded in the task which I originally set myself, I have made it clear that of all sciences as we know them to-day, "Electricity *is the most* exact." I lay myself open here to very many accusations, and I would attempt to deal with the charge which is likely to be preferred against me by the greatest number of scientific workers. I mean that I shall probably be told on all hands: "Ah, yes, but you have not studied our science, so your claim is absurdly unscientific; how dare you make it?" In such a case, my answer would be, Is there any living man who has completely studied any single science? I am free to admit that I have by no means done this as regards electricity, and with reference to any other science concerning which I may have gleaned a few facts, it is highly probable that my knowledge there is only sufficient to be dangerous.

Yet, from what I know of electricity I am compelled to the assertion that not all the other sciences put together, excepting perhaps mathematics, have contributed to the advancement of matters electrical so much as the expansion of electrical undertaking has added to almost any single one of its sisters which have been longer in practice.

Even at the risk of seeming impertinent (need I explain that my object is simply to bring out the truth?), I would venture to assert that electrical practice *per se* to-day is saving human life at a greater rate than that accomplished by medical practice. Also it should not be forgotten that while doing this *the* science finds time to vastly strengthen the hands of the medical practitioner to a far greater extent than has occurred in the other direction.

Again, the bacteriologist, or let us say the chemist, owes more individually to the electrician than the latter owes to them collectively. But it seems at best ungracious to continue expatiating upon such a theme. Let us look upon the other side of the medal.

Electrical science owes almost every good thing it has to show to mathematical reasoning. Indeed it is just because so very many electrical problems can be worked out upon a basis of pure mathematics that electricians are so frequently able to prophesy. Mechanical engineers do this, too, to a great extent, yet not, I think, quite so often as

electricians, added to which, the calculations of mechanical stresses and strains, steam pressures, and the heat to be got from any particular fuel, are not yet quite so nicely calculable as we may expect to see them in the future.

In this connection I would turn aside for a moment, and endeavour to make clear a point which I attempted to bring out in the first chapter of this series. I stated there (p. 20, bottom right) that "Electrical science owes its present position to the facts, and distortions of fact, propounded by the ancients." This statement has since been called into question more than once, and I have been blamed for asserting that any science could be indebted (in any circumstances) to a distortion of fact. Doubtless I did not express myself well there. What I meant to imply was that a deliberate untruth which savours of the marvellous will often draw attention to the subject concerning which it has been told, and so, investigation in a thoroughly honest spirit will frequently ensue.

And, since "There must be no finality"—I forget from whom I am quoting, but remember that the remark was made some time since with reference to electrical research—shall I be transgressing if I venture to point out that scientific workers everywhere are constantly having a "full stop" put to their undertakings by a most vexatious system which unfortunately prevails among us?

As we approach the dawn of the twentieth century it is depressing to find that, while the Institution of Electrical Engineers has taken great pains to formulate a series of rules for the wiring of houses, yet that body has absolutely no power to enforce the adoption of such rules.

In this connection many other instances of something like grave (if not culpable) stupidity on the part of some person, or persons, could be cited. Anyone who has carefully studied several reports of the proceedings of Royal Commissions, or of Board of Trade enquiries, will in all probability see quite clearly what I mean.

But, the disease having been alluded to, what is the remedy?

Expert evidence is almost invariably discounted, and as a rule to no small extent, simply because the legal mind (having devoted very much the greater part of its energy to the study of "the Law") has neither the time nor the capacity to understand nice points of technical difficulty. This being the case, why should not recognised scientific bodies become, to a much greater extent, a law unto their several members? Must the settlement of some intricate point connected with polyphase distribution be discussed, argued, and finally decided upon, by men who are uncertain yet as to whether it is or is not possible to find a spot on earth which cannot be regarded as a place?

What is to be done? As time goes on the "infant" will some day attain its majority, and demand its inheritance. What then will be the position of its guardians for the time being if they have to answer that the heritage referred to is in Chancery, or has been "fisked" by some constituted authority?

But it is by no means only electrical science which is like to be kept out of its own—at least for a longer period than is right. Every other useful science is "put upon" in the same manner.

And the one hope seems to rest upon the chance that some day all scientific bodies will develop a far better feeling of public spiritedness and, in consequence, will unite, so strengthening the position for themselves in the first place, then, following up this action, will make a dispassionate appeal to a right-minded government, asking only that something may be done to remove this stumbling block.

I am suggesting no Utopia, but venture to urge that at least one step be taken in the direction I have ventured to indicate.

UPS AND DOWNS IN OUR DAILY WEIGHT.

By W. W. Wagstaffe, B.A., F.R.C.S.

THESE are days of "penny in the slot," and possibly everyone weighs very frequently for his own amusement. Even if the machines are not very accurate, the probability is, that if you weigh regularly on the same machine, you can see correctly whether you increase or diminish in weight.

We are not concerned here with the steady increase or diminution in weight at various times of the year, or before and after an illness; but I want to draw attention to the fact that in health we vary in weight from hour to hour, and that this does not seem to be recognized.

It is strange to see what absurd fallacies occupy the popular mind. *A propos* of the subject of this paper, it has been seriously asserted by many people that you are naturally lighter after a meal, and they have even gone the length of explaining this by the amount of gas that is developed from the food. These people must be very uncomfortable after meals! It reminds one rather of the famous fallacy said to have been submitted to the Royal Society, asking why a fish could be put into a basin brimful of water without making it run over. When it was tried at someone's suggestion the water, of course, did run over.

Supposing we want to find whether we do really vary in weight or not, there are two ways to set about the enquiry. We can either sit in a weighing machine and live there—which does not commend itself to most of us—or we can weigh ourselves at regular times during the day, which is more feasible. Now common sense points out that we must vary in weight according to the amount of food we take in, and the amount of material that we lose.

In the following chart the observations are arranged in such a way as, I think, will make them clear. Statistics are always painful, unless the writer has the wonderful power of Mr. Schooling, who certainly can make statistics attractive. But, perhaps, the most convenient method is to look at the summary diagram first, and this shows what can be represented in figures without much difficulty.

Average.	lbs.	ozs.		lbs.	ozs.	
9 a.m.—Before breakfast	155	8	(losing	3	6)	during night.
10 a.m.—After ,,	157	4	(gaining	1	12)	
12 noon.—Before lunch	156	6	(losing	0	14)	
1 p.m.—After ,,	157	6	(gaining	1	0)	
5 p.m.—Before dinner	156	12	(losing	0	10)	
6¼ p.m.—After ,,	158	14	(gaining	2	2)	

By these it will be seen that we lose three pounds six ounces between night and morning; that we gain one pound twelve ounces by breakfast. That we again lose about fourteen ounces before lunch; that lunch puts on an average of one pound; that we again lose during the afternoon an average of ten ounces; but that an ordinary dinner to healthy persons adds two pounds two ounces to their weight. What would be the result of a big dinner? It is easier to imagine than to describe. And yet on more than one day there was a difference of two pounds eight ounces; but this is not very excessive considering that a pint of fluid weighs about a pound.

Now what are the greatest differences here recorded?

The greatest difference was between the night and morning of three pounds twelve ounces, and this may be accounted for by the natural loss of weight, partly by the perspiration at night, which is variously estimated by dif-

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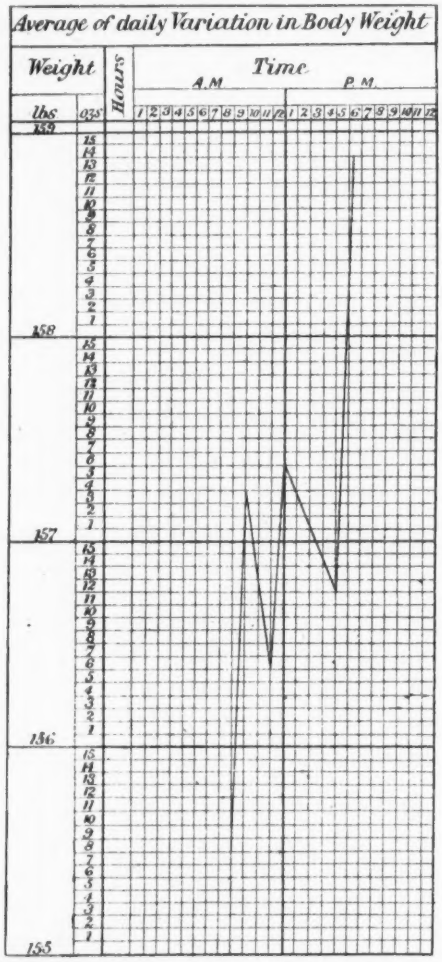
ferent authorities at from two to four pounds, and partly by the natural loss of weight from obvious causes. It



would be a simple course to weigh the *excreta;* but has this been done?

The foregoing are the average weights of a healthy man, engaged in ordinary work; however, fuller observations are certainly wanted.

Some very curious records of variations in body-weight at different times in the year have been given by a Danish observer, Mr. Hansen, but these are what may be called periodic phenomena. If children be studied—and these are more closely related to the lower forms of animal and vegetable life than are adults—periods of growth, of fattening, and of equipoise are distinguishable. Mr. Hansen, of Copenhagen, from a very large series of observations of children, shows that there is an increase of weight from August to December, and a season of growth from April to August, and a period of rest both in weight and growth from December to April. These observations, however, do not touch the question which this paper tries to make rather clearer—that of daily variations in body-weight in a healthy person.

If any one were careful to take similar observations in asylums, infirmaries, and hospitals, it is quite possible some difference might be found according to age, sex, and conditions of disease, and it is possible there might be a difference according to nationality.

What has been learnt from the weighing of a fasting man at different times? And would not periodical weighing help to detect some of the shammers?

I think it will be seen from the above that it is important to choose the time for weighing a recruit, or even a person submitting himself to life insurance, and is it not a matter of interest to all of us to learn a little more about ourselves in any way?

IS THE STELLAR UNIVERSE FINITE?

By GAVIN J. BURNS, B.Sc.

IN my paper on the "Distribution of Stars in Space,"* I advanced some facts and observations which tend to show that the number of faint stars is much smaller than it would be on the hypothesis that stars of all degress of intrinsic brightness are uniformly distributed throughout space, and so the stars present the appearance of thinning out as we recede from the solar system.

There appear to be four possible hypotheses as to the probable cause of the reduction in the number of faint and telescopic stars:—

1. Absorption of light by the luminiferous ether.
2. Absorption of light by a gas filling interstellar space.
3. Absorption of light by cosmical dust.
4. A progressive decrease in the density of stellar aggregation as the distance from the sun increases.

The loss of light in passing through a semi-transparent medium will augment as the distance increases and the light of the most distant stars practically obliterated.

1. We may dismiss the hypothesis that a plane wave of light diminishes in amplitude in traversing the luminiferous ether as being void of experimental foundation; moreover, it is difficult to reconcile with the law of the conservation of energy. When light is absorbed in its passage through a material medium, it is transformed into heat, and the medium is warmed; but in traversing the ether, what would become of the heat?

2. Regarding the hypothesis that the interstellar spaces are filled with matter in the gaseous form, matter can only exist in the attenuated state when above a certain temperature, and in extra-terrestrial space a cold obtains akin to absolute zero in which known gases would be congealed; besides, if a gas were diffused throughout space, we should expect to see its absorption lines present in the spectra of all stars, but no such lines have been observed.

3. Absorption of light by cosmical dust must be regarded as not only possible but probable; the only pertinent question which presents itself is—what is the quantity distributed and the amount of light it can intercept? Suppose that at some remote period of time cosmical dust was densely scattered throughout all space, producing an effect on the light of the stars like that of a terrestrial fog, causing the nearer lights to be dimmed, and the farther ones entirely obscured; then, if these particles of dust were originally at rest, they would not remain so; for, since gravitation is universal, each particle would begin to move towards some centre of attraction and its motion continue with ever-increasing velocity till it reached the attracting centre; thus, in a comparatively short space of time, the whole of the cosmical dust would aggregate around the larger masses which might, or might not, be lucid stars. If the particles of cosmical dust were originally in motion, a like result would follow, the time required being greater, for each particle, moving till it came within the influence

* *See* KNOWLEDGE, July, 1899, p. 152.

of some attracting mass, would ultimately fall therein, the particles of highest initial velocity deferring this common fate the longest. The extraneous comets and meteors that visit the solar system must be considered as a few scattered fragments that have avoided capture. The light intercepted by the small bodies that still wander in space unattached to an attracting centre we may look upon as a negligible quantity.

4. There remains the hypothesis—the only natural and obvious one—that the stars do really thin out and ultimately cease as their distance from us increases. On the supposition that the stars are infinite in number, it follows that a straight line drawn in any direction from the eye of an observer on the earth will ultimately meet a star. Now, it is a well-known law in optics that the brightness of a body is independent of the distance, and that the quantity of light received from a sphere of constant brightness only depends on the area of its apparent disc; consequently the total light received from a number of stars is proportional to the total area of their apparent discs; but, if the number of stars were infinite, this area would be simply that of the whole sky; hence we should have the whole sky one blaze of light! Therefore the number of stars must be finite.

It does not, however, absolutely follow that the stellar universe is finite. We may escape from this conclusion by imagining that outside the luminous stars there is an infinite number of dark bodies that are never seen, and that the visible universe is bounded by clouds of cosmical dust which conceal everything beyond; but this is unsupported by evidence.

A reference to popular works on astronomy will show that there is a great reluctance to adopt the view here presented. "We cannot imagine such a thing to be possible" is the argument put forward. What any person thinks possible or impossible depends on his mental constitution.

Granting that the universe is finite in space it follows that it is finite in time, for the quantity of matter and of energy it contains are both finite; the energy is being steadily dissipated in the form of radiant heat; this constant loss of heat cannot have persisted for an infinity of time past, and it must end in the future.

But if we adopt the hypothesis of a finite universe, we at once meet with a number of questions which it is impossible to answer. What, for instance, is the destination of 1618 Groombridge, with its velocity of two hundred and thirty miles per second? It has been calculated that this star must pass out of the stellar universe altogether, there being no known force sufficient to restrain it. Are there other universes constructed on different principles from ours? Is the ether finite? and what becomes of the heat constantly radiated into space? Perhaps the real solution of the difficulties thus presented by a finite universe is metaphysical. The human intellect is so framed that it can only conceive space as infinite, and yet can form no conception of infinite space. Possibly space without limit is a mental illusion.

The only satisfactory method of dealing with such a question as the limits of the stellar universe is by inference from observed facts.

[We fear Mr. Burns' handling of this subject is scarcely conclusive. We have no means for experimenting on the first of his four hypotheses. Mr. Burns' second argument proves too much. It would follow that the existence of matter in the gaseous state is impossible in interstellar space, a conclusion which the existence of gaseous nebulæ of enormous tenuity and extent appears to controvert. Under the third head he supposes that the particles of cosmical dust would all soon fall in to some attracting body; whereas they would revolve round it in nearly all cases. Whilst the assumption that if the stars were infinite in number, "the whole sky would be one blaze of light," supposes something as to their distribution. We see that the earth is small as compared with its distance from the nearest other planet, and that the solar system is small as compared with the distance separating it from the nearest star. If the same rule prevails on the larger scale; if the dimensions of star systems are small as compared with the distances between them, then "a straight line drawn in any direction from the eye of an observer on the earth, will," in most cases never "meet a star."—E. WALTER MAUNDER.]

PHOTOGRAPH OF NEBULÆ SURROUNDING THE STAR D.M. NO. 1848 MONOCEROTIS.

By ISAAC ROBERTS, D.SC., F.R.S.

THE photograph annexed is of the region in the sky comprised between R.A. 6h. 57m. 53·5s. and R.A. 7h. 2m. 52·7s., and in declination between south 11° 9′·9 and 9° 34′·1. The area, therefore, is 4m. 59·2s. in extent from *following* to *preceding*, and 1° 35′·8 in south declination. Scale, one millimètre to twenty-four seconds of arc.

Co-ordinates of the fiducial stars marked with dots for the epoch 1900.

Star (.) D.M. Schönfeld No. 1818 Zone −9° R.A. 6h. 59m. 12·9s. Dec. S. 9° 58′·6. Mag. 6·3.
Star (..) D.M. No. 1862 Zone −10° R.A. 7h. 1m. 6·3s. Dec. S. 10° 30′·5. Mag. 7·0.
Star (∴) D.M. No. 1854 Zone −9° R.A. 7h. 2m. 36·7s. Dec. S. 9° 49′·7. Mag. 7·3.

The nebulæ I assume to be new to science, for they are not referred to in the catalogues, and by referring to the nebula N.G.C. 2237–9 Monocerotis, a photograph of which was published in the number of KNOWLEDGE for June last, it will be seen that the three nebulæ are in near proximity to each other.

The photograph was taken with the twenty-inch reflector, and exposure of the plate during 2h. 47m., on the 9th of March, 1899, and it shows the brighter nebula to be of a flocculent character with some faint star-like condensations involved, and the star D.M. 1848, which is *north preceding* the centre, seems to be on the margin of a dark sinuous vacancy, or rift, in the nebula, through which we can see into the starless vacancy of space beyond it. Sharply-defined zig-zag dark rifts have been shown on other photographs of cloud-like extensive nebulæ which have been published in KNOWLEDGE, notably that designated N.G.C. 2237–9 Monocerotis, and in a less striking manner, N.G.C. 1499 Persei, H V. 37 Cygni, H V. 14 Cygni, the Great Nebula in Orion, and others. The "keyhole" in the nebula round η Argûs greatly resembles that shown in this nebula.

These vacancies are most conspicuously seen where the surrounding nebulosity is dense, though they are also visible in some parts where it is relatively faint. The margins of the vacancies are often sharply defined and suggestive of the idea that in consequence of some internal strain, operating from opposite directions, the nebula was rent asunder and the parts separated from each other. We could also imagine that another nebula, of smaller area than this, moving in space at nearly right angles, and being edgewise to it, rushed through carrying along in its course so much of the material of this nebula as would be represented by the sectional area of the other, and thus

producing a vacancy resembling the sectional contour. At first sight this idea would appear to be too improbable, but if we examine some of the nebulæ that have been photographed and presented to our view nearly as straight lines because they are seen edgewise, and others seen nearly edgewise and with rugged irregular surfaces which are not unlike some of the outlines of these vacancies, we should admit that there is some force in this suggestion. This nebula presents, roughly, a circular surface with a large gap cut out of it on the *north following* side. It measures about twenty-two minutes of arc from *south following* to *north preceding*, and eighteen minutes from *north following* to *south preceding*. On the south, *south following* and onwards to *north following*, is an extensive faint cloud of nebulosity more than one and a half degrees in extent, and apparently connected by faint streams of nebulous matter with the nebula just described. It curves round the fiducial star (..), and almost touches fiducial star ('.').

The surfaces of these nebulæ are strewn with numerous stars besides the nebulous condensations which are, doubtless, involved in the nebulosity, but it is probable that the stars are not involved, and are placed either behind or else in front between the earth and the nebulæ.

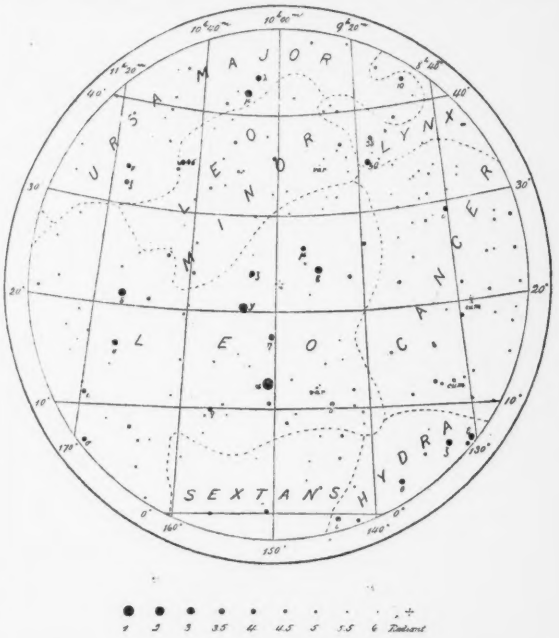
The stars that are shown to be distorted on the photograph are double or multiple stars, although it does not follow that they are physically connected, and it will be many years hence before this can be either proved or disproved because of their vast distances from the earth.

THE NOVEMBER METEORS OF 1899.

THE predicted time of maximum of the November meteors is November 15th, 1899, at 18h. Greenwich mean time. As a similar shower may not occur again for thirty years, no pains should be spared to secure the best possible observations. The most useful observations that can be made by amateurs are those which will serve to determine the number of meteors visible per hour throughout the entire duration of the shower. Circular No. 31 was accordingly distributed last year, and numerous valuable observations were thus secured from observers in all parts of the world. The results are now being discussed by Professor W. H. Pickering, and will be published later in the Annals of the Harvard Observatory. Similar observations are desired this year, and it is hoped that they may be made on November 15th, and also on the two preceding and following evenings. The most important time for observation is from midnight until dawn, as comparatively few meteors are expected earlier. Observations are particularly needed at hours when they cannot be made at the observatories of Europe and America. In general, the time required for ten or more meteors to appear in the region covered by the accompanying map should be recorded. This observation should be repeated every hour or half-hour. If the meteors are too numerous to count all those appearing upon the map, the observer should confine his attention exclusively to some small region such as that included between the stars μ Ursae Majoris, 40 Lyncis, δ and α Leonis. If the meteors occur but seldom, one every five minutes, for instance, the time and class of each meteor should be recorded. Also, note the time during which the sky was watched and no meteors seen, and the time during which that portion of the sky was obscured by clouds. Passing clouds or haze, during the time of observation should also be recorded. The date should be the astronomical day, beginning at noon, that is, the date of early morning observations should be that of the preceding evening. Specify what time is used, as Greenwich, Standard, or Local Time. When a meteor bursts, make a second observation of its light and colour, and when it leaves a trail, record the motion of the latter by charting the neighbouring stars, and sketching its position among them at short intervals until it disappears, noting the time of each observation. If the path of a meteor is surely curved, record it carefully upon the map.

On November 14th, 1898, thirty-four photographs were obtained of eleven different meteors. Their discussion has led to results of unexpected value. The greatest number of meteors photographed by one instrument was five. Only two meteors were photographed which passed outside of the region covered by the map, although the total region covered was three or four times as great. No meteors fainter than the second magnitude were photographed.

Photographs may be taken, first, by leaving the camera



at rest, when the images of the stars will trail over the plate and appear as lines, or, secondly, attaching the camera to an equatorial telescope moved by clockwork, when a chart of the sky will be formed, in which the stars will appear as points. A rapid-rectilinear lens is to be preferred in the first case, a wide-angle lens in the second. The full aperture should be used, and as large a plate as can be covered. The most rapid plates are best for this work; they should be changed once an hour, and the exact times of starting and stopping recorded. Care should be taken to stiffen the camera by braces, so that the focus will not be changed when the instrument is pointed to different portions of the sky, especially if the lens is heavy. If the first method is employed, the position of the camera should be changed after each plate, so as to include as much as possible of the region of the map on each photograph. If pointed a little south-east of ε Leonis, the radiant will reach the centre of the field about the middle of the exposure. A watch of the region should also be kept, and the exact time of appearance and path of each meteor as bright as the Pole Star should be recorded. The plates should be numbered on the film side with a pencil, and should be sent to this Observatory with accompanying

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XUM

NEW NEBULÆ IN MONOCEROS.

By ISAAC ROBERTS, D.Sc., F.R.S.

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notes and other observations. After measurement here, they will be returned if desired. The value of the results will be much increased if similar photographs can be obtained by a second camera from ten to forty miles distant, and preferably north or south of the other.

EDWARD C. PICKERING.

Harvard College Observatory, September 18th, 1899.

THE "SEAS" OF THE MOON, WHAT ARE THEY, AND WHAT IS THE CAUSE OF THEIR OBSCURE APPEARANCE?

By J. G. O. TEPPER.

THE dark areas in the moon known as "Seas" were originally considered to be real seas, but now that it is known positively than no water can exist there, either as such, or as ice, or vapour, the dark areas still remain unexplained. For, while perfectly visible at the full in distinct outlines of one form, they either disappear entirely in very oblique light, or their form is wholly changed. This shows that the dark appearance is merely the effect of excessive absorption of light, and of diminished reflection according to the incident angle, but not of irregularity of surface, *i.e.*, effect of shadows.

In venturing to suggest a *possible* explanation, I do so with the distinct aim of initiating a discussion on the phenomenon, and not of proving the suggested hypothesis as anything more than probable.

The moon is known, or rather accepted, to be a dead world, *i.e.*, one once exhibiting similar phenomena of physical life to our own, viz., supporting vegetable and animal organisms.

Now what would happen if our Earth suffered the same fate?

The great bulk of both plants and animals consists of water and carbon. The burning of the latter, its combination with oxygen, produces the bodily warmth requisite for animal life, the combination escaping in gaseous form into the atmosphere as carbon dioxide (CO^2) popularly known as carbonic acid, which in Nature plants alone can dissociate, and so as to reproduce the carbon in suitable form for food. Besides this, carbon forms the fuel for the production of artificial heat, as wood, coal, kerosene, etc.

If the water supply is at all small in comparison with anhydrous minerals eager to combine with it into permanent heat-resistant compounds (rocks), it will gradually diminish and finally disappear. The same will be the case with the nitrogen of the air as well as the oxygen, the greater part of oxygen being locked up for the time in vegetable substances, such as wood, coal, mould, and animal bodies, while nitrogen would principally be absorbed by animals and caustic alkalies together with the remaining oxygen.

With the diminution of the water, and the atmospheric gases the decay (disintegration) of dying organisms would be at first more and more delayed until all were dead besides the *mould* of the soil, the last memorials of organic life.

There being no longer any amelioration of heat or cold through the biophysiological action of plants, air, etc., they would now succeed each other without gradation. While the cold would tend to preserve the carbon compounds, the heat, with the sun pouring its rays on the highly absorbent rocks for half a month would probably raise their temperature to, or above, 200° or 300° Cent.; then the organic bodies would be gradually dissociated (not *burned* but charred, for there would not be sufficient oxygen), the excluded gases and moisture would be eagerly appropriated by the nearly red hot minerals, and locked up permanently among the rocks.

The only substance that would remain unprovided for on account of its weak affinities to any of the common gases at high temperatures would be carbon, and most likely in the form of dust, or minute flakes, wafted by the more and more decreasing currents of the last remnants of an atmosphere to the lee of gentle declivities, and upon the great low-lying plains, wherever the opposing currents counterbalanced each other.

Since the total disappearance of the atmosphere no currents can possibly exist, and the finest, lightest dust must remain eternally undisturbed, except by the rude shock of a colliding meteor, or when ploughed aside by such, if gliding along after a very oblique impact.

It is well known that there is no body more absorptive of light than finely divided carbon particles, hence their intensely black aspect. At the same time, dust, or loosely cohering matter, reflects little light, except at very oblique angles of incidence.

In the "seas" of the moon we may, therefore, have large areas covered by carbonaceous dust, the last remains and the last evidence of the former vegetable and animal organisms of our satellite. For the one class cannot possibly exist without the other, unless in the lowest forms known as Protozoa and Protophyta (*i.e.*, the same organism discharges the function of both, in absorbing carbon and nitrogen exclusively).

As an hypothesis the above appears to me to fulfil most, if (perhaps) not all, the conditions demanded in the works perused by me, and I shall be glad to learn wherein it fails.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

"MAN; PAST AND PRESENT."

To the Editors of KNOWLEDGE.

SIRS,—In his appreciative notice of this book, for which he has my best thanks, your reviewer objects to my use of the expressions "old stone age" and the "new stone age" as applied to "chronological periods; more properly they apply to stages of culture. We cannot but think that such abuse of the terms leads to much confusion. We speak of a neolithic period as if it were a past age. So it is, so far as we are concerned, but it may be pointed out that there are still many savage races living in a stage of neolithic culture." This is also my teaching, and I take some pains to make the matter plain in the "Ethnology," which the writer has evidently not seen, but is necessary to the right understanding of "Man; Past and Present." Thus, p. 72: "The question is beset with snares and pitfalls, due especially to the fact that the very terminology itself does not everywhere connote the same order of sequence, much less the same periods of absolute time. Thus palæolithic implements in the New may in some cases correspond with neolithic implements in the Old World, and in all the continents except Australia, where one order alone exists, various phases of progress go on simultaneously rather than consecutively." After giving several instances, I go on (p. 73): "Such overlapping of old and new, such persistence of low primitive cultures in the midst of highly advanced populations, tend to obscure the time relations, which are here under consideration. It is obvious, for instance, that implements of the most

primitive types . . . . cannot of themselves be any test of age. They represent no sequences, but only an incipient growth permanently arrested and by adverse conditions prevented from attaining its normal development. Where there is no change there is no standard by which to measure time. Hence the mistake made, especially by some American ethnologists, who have assigned a considerable antiquity to certain native cultures, solely on the ground of the rude implements with which they appeared to be associated. Certain objects, such as flint flakes or chippings, if found on or near the surface, or under other circumstances not necessarily involving great age, might have been made at any time, and are now still made by many peoples not yet brought under higher influences." Hence readers of the "Ethnology" understand quite well that the expressions in question are used in "Man; Past and Present" not in an absolute, but only in a relative sense, implying time sequence not universally, but only in the culture areas.

Farther on the reviewer criticises the use of the term "cornea" as applied to the yellowish sclerotic of the negro peoples. Here, also, a reference to the "Ethnology" ("sclerotic" in the European whitish, in the negro yellowish, pp. 186-7) shows that I am speaking, not of the *Cornea vellucida over* the iris, which, of course, is transparent and colourless, but of the *C. opaca round* the iris, the colour of which varies racially. The two books are intended to be read together, and I may here add that they form parts only of an ethnological treatise which I hope to complete in a third volume. Then many things which now seem strange, and have laid me open to criticism, especially by specialists, will be made clear. A. K. Keane.

TREE STRUCK BY LIGHTNING.

To the Editors of Knowledge.

Sirs,—I have read with much interest Baron Kaulbars' letter in your issue of this month, as a parallel case to those he mentions occurred in 1852 to a large old oak tree in Westwood Park, near Droitwich. The tree was completely uprooted, and the trunk shivered into three parts, the remains of which are still lying where they fell. The boughs were rent and scattered in all directions, some to a distance of many feet. Such a result of lightning was, I think, then considered to be unique, and Faraday was asked his opinion as to the cause. He held that the lightning must have got down the hollow stem, and, meeting with damp at the bottom, generated steam, and so caused an explosion. After reading Baron Kaulbars' letter, I have no doubt it was the true explanation. It is possible this case may still be unique as an effect of lightning on a *tree*, as the only precisely parallel case Baron Kaulbars gives is the very curious one of the monumental column in Gatchina. Hampton.

Waresley Court.

SUSPECTED VARIABLE STARS.

To the Editors of Knowledge.

Sirs,—I object to convicting anything on suspicion, be it man, woman, or star, and although my friend Mr. Gore's suspicions would be quite sufficient to convince the Home Office in the case of a convict, they do not convince me.

With regard to photometric measures, the Pole Star has been always (I think) adopted as the standard. But what if the Pole Star varies in its light? I have not as yet seen the details of the alleged discovery made in relation to it at the Lick Observatory; but with a binary or ternary system of very short period there must always be a considerable risk of one of the members of the system overlapping another and thus diminishing the light. If this occurs with the Pole Star, its variations may cause other stars to be erroneously suspected.

Then, as to stars whose light is of different colours, it is probable, as Mr. Backhouse remarks, that different observers will rate them differently, owing to the peculiarities of their sight. One eye may be more sensitive to white light and another to light with a reddish tint. And very possibly there may be a systematic difference on this point between the Oxford and Harvard photometries in which the methods of estimating star-magnitudes are different. I would lay very little stress on one observer describing Vega as brighter than Arcturus, while another described Arcturus as brighter than Vega. Nor is this difficulty surmounted by photometry. The ultimate comparison is made by the eye, and the colour of the stars may affect this. We must have the same observer in order to prove the variation, unless the amount is large. And even with the same observer the result is open to question. The stars are probably not at the same altitude, and a larger proportion of the light of the star is absorbed when the star is at a low altitude than when it is at a high one. But we have further a proof every moonlight night of how much the visibility and brightness of a star depends on the condition of the surrounding portion of the sky. Indeed, but for this, all the stars would be seen in the day time. Hence a star which lies pretty low in the west will look faint after sunset, as one which lies pretty low in the east will look faint before sun-rise. And on a moonlight night a star near the moon will look fainter than one remote from it. We may, perhaps, even underrate the magnitude of a star in or near the Milky Way owing to the comparative brightness of the surrounding portion of the sky.

As to star-magnitudes, it is only very recently that any scientific scale was adopted for measuring them. Even Sir J. Herschel seemed to conclude that we could not go beyond 0, and thus crowded an undue number of stars into the interval between 0 and 1. The chief value of magnitudes determined without the guidance of any fixed scale seems to consist in showing which of two stars was regarded as the brighter by a person who observed both. Double stars often afford examples of the defects of eye-estimates not guided by principle. Take for example Castor and γ Leonis. Referring to the *Handbook of the Double Stars* (ed. 1879), I find the components of Castor given as 3·0 and 3·5 (in the catalogue 3 and 4) and those of γ Leonis at 2·0 and 3·5 (in the catalogue 2 and 3). Webb (ed. 1881) gives for Castor 2·7 and 3·7, and for γ Leonis 2·0 and 3·5. According to these estimates γ Leonis would of course be the brighter star. I find similar estimates given as late as the last edition of Mr. Chambers' *Descriptive Astronomy*—and Prof. Pickering published an elaborate computation based on them as well as the supposed orbits. But it is beyond question that Castor is brighter than γ Leonis by at least half a magnitude, and consequently the estimated magnitudes of the components must be seriously in error. Even as regards Algol the old estimate of the reduction of the light by two magnitudes seems to be generally current, notwithstanding the photometric measures of Prof. Pickering, which make it almost exactly one magnitude.

That some of Mr. Gore's "suspects" are really guilty I can quite believe, but I think we require a further investigation into the causes of variation in observers' estimates. I have an idea, too, that an examination of the spectrum of a star would often tend to confirm or remove the suspicion. A good determination of the spectra of all known variable stars would, I believe, form a very useful guide to the examination of suspicious objects.

W. H. S. Monck.

R. LEONIS, MIRA, AND S. S. CYGNI.

To the Editors of KNOWLEDGE.

SIRS,—A maximum of R. Leonis was predicted for June 26th, 1899, but eliminating all corrections and seeming errors, and computing from previous data, especially from Gore's observation of February 17th, 1890 (*B. A. A. Reports*), which was, according to Yendell (*Pop. Ast.*, June 1897), four days late, the maximum should have occurred July 23rd of the present year. I have followed the star assiduously this season, and hope the figures presented will show a curve characteristic of this highly interesting variable.

		Mag.			Mag.
Feb.	19, 27 ...	10·00	May	5 ...	8·05
Mar.	2 ...	10·00	,,	6 ...	7·90
,,	8 ...	9·70	,,	7 ...	7·85
,,	9 ...	9·75	,,	8 ...	7·65
,,	12 ...	9·60	,,	9 ...	7·10
,,	15 ...	9·50	,,	12 ...	6·90
,,	19 ...	9·32	,,	13 ...	6·95
,,	28 ...	8·80	,,	14, 15 ...	7·00
,,	29, 30 ...	8·70	,,	16 ...	6·87
Apr.	1 ...	8·65	,,	19 (red)	6·35
,,	4 ...	8·45	,,	20, 21 ...	6·25
,,	8 ...	8·47	,,	24, 25, 26, 27, 29, 31	6·25
,,	9 ...	8·37	June	1, 2, 3, 4 ...	6·25
,,	12 ...	8·00	,,	5, 6, 7 ...	6·30
,,	15 ...	8·15	,,	13 ...	6·35
,,	16, 17 ...	7·90	,,	14 ...	6·30
,,	23 ...	8·10	,,	17 ...	6·45
,,	25 ...	8·05	,,	18, 19 ...	6·40
,,	26 ...	7·90	,,	21 ...	6·50
,,	27, 28 ...	7·95	,,	22, 23 ...	6·55
,,	29 ...	8·05	,,	27, 30 ...	6·65
,,	30 ...	8·00	July	2 ...	6·95
May	1 ...	7·95	,,	3 ...	7·10
,,	3 ...	7·90	,,	5 ...	7·15
,,	4 ...	7·41	,,	9 ...	7·40
			,,	10 (lost behind trees).	

Putting the maximum on May 21st, the star is still, allowing all corrections and errors, thirty-five days ahead, and by my own figuring sixty-three days. The following is a record of S. S. Cygni, maximum just passing:—

		Mag.			Mag.
Aug.	22 (invisible)		Sep.	2 ...	8·15
,,	23 ...	8·25	,,	3 ...	8·30
,,	24 ...	8·20	,,	4 ...	8·35
,,	25, 26 ...	8·05	,,	5 ...	8·90
,,	27, 28, 29, 30	8·25	,,	6 ...	9·60
Sep.	1 ...	8·30	,,	7 (last seen)	10·00

There is no error or mistake in the light of the star on August 25th and 26th, as it stood out bright and distinct from its surroundings.

My first view of Mira o Ceti this season was on July 19th at 3 a.m., when it was about 7th magnitude, and I have eighteen observations since then, more than one-half being in the small hours of the morning. From July 19th to August 20th, the star advanced slowly and came to a halt, at which it remained for several days and then fell slowly, reaching 5th magnitude when last seen September 7th. Whether the maximum is past or one is to come remains to be seen.

Memphis, Tenn., U.S.A., DAVID FLANERY.
11th September, 1899.

British Ornithological Notes.

Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

Rose-coloured Pastor in Ireland (*Irish Naturalist*, October, 1899, p. 230).—Mr. E. Williams records that an adult male of this species, which is of very irregular occurrence in Ireland, was shot by Mr. A. Brooke, at Killybegs, Co. Donegal, on July 20th last.

Night Heron in Co. Wexford, Ireland (*Irish Naturalist*, October, 1899, p. 230).—Mr. G. E. H. Barrett-Hamilton records that a male of this species was shot near Killinick, and is now in the Dublin Museum. The Night Heron is a rare visitor to Ireland. Mr. Hamilton thinks that only fifteen instances of its occurrence have been recorded, while Mr. Saunders puts the number at about twenty.

Wood Sandpiper in Co. Waterford, Ireland (*Irish Naturalist*, October, 1899, p. 231).—Mr. E. Williams writes that a Wood Sandpiper was shot by Mr. J. F. Knox on the Black Strand, Tramore, Co. Waterford, on August 26th last. This is only the fifth specimen of the species which has been recorded for Ireland.

Increase and Decrease of Certain Species of Birds in the Tay Area. By Col. John Campbell, M.B.O.U. (*Annals of Scottish Natural History*, October, 1899, pp. 198-206).—Col. Campbell gives an interesting and satisfactory history of the increase of the Tufted Duck, the Pochard, the Widgeon, the Shoveller, and the Stock Dove in the Tay area. He also gives reasons for the deplorable decrease of the Goldfinch, Dotterel, Spotted Woodpecker, and other birds, and suggests remedies. The paper is a valuable addition to others of the same kind which have appeared from time to time in the pages of our contemporary.

Observations on the Birds of the Islands of Tiree and Coll. By Lt.-Col. L. H. Irby, F.L.S., F.Z.S. (*Annals of Scottish Natural History*, October, 1899, pp. 206-210).—Col. Irby here supplements a list of the birds in Tiree by Peter Anderson, published in the same magazine in July, 1898.

Scaup-duck Nesting in Scotland. By J. A. Harvie-Brown (*Annals of Scottish Natural History*, October. 1899, pp. 215 and 216).—Mr. Harvie-Brown publishes a communication which he has received from Mr. H. Noble, to the effect that he found in June the undoubted nest of *Fuligula marila*, in Sutherlandshire. Mr. Noble identified the male at close quarters, and saw the female leave the nest. The nest was deep, cup-shaped, and better made than most ducks' nests. There were nine eggs. The Scaup is a very common bird on our shores in the winter months, and although it has several times been asserted that the bird has bred in Scotland, this is the first record which has been confirmed.

Buff-breasted Sandpiper in Norfolk (*Zoologist*, October, 1899, p. 475).—An immature male specimen of the American wader (*Tringites rufescens*) was shot by Mr. E. C. Arnold on September 7th, between Wells and Cromer. This bird is an exceedingly rare straggler to our islands.

Icterine Warbler in Norfolk (*Zoologist*, October, 1899, p. 475).—Mr. E. C. Arnold records that he secured a specimen (sex not mentioned) of this bird on September 5th, between Wells and Cromer. The bird has been identified by Mr. J. H. Gurney. Although a common enough species on the Continent, we believe that the above is only the ninth example which has been identified in the British Islands.

Breeding of the Tufted Duck in South-west Derbyshire (*Zoologist*, October, 1899, p. 476).—From a note by the Rev. Francis C. R. Jourdain it seems that this bird now breeds regularly in several places in Derbyshire.

Grey Phalarope in Co. Armagh, Ireland (*Zoologist*, October, 1899, p. 477).—Mr. Marsden received, on September 30th, a young male of this uncommon visitor to Ireland from Mr. W. Keatley, who shot the bird on the Logan on September 28th.

All contributions to the column, either in the way of notes or photographs, should be forwarded to HARRY F. WITHERBY, *at 1, Eliot Place, Blackheath, Kent.*

Science Notes.

The Buckinghamshire Archæological Society has finished for the season the excavating work which it resumed at Hedsor after a lapse of some years. Originally brought to light in 1894, this site of pile dwellings in the Thames Valley ranks with the few, such as those at Glastonbury and Braintree, which have been discovered in the southern part of this island. One must not judge of the interest which surrounds the place in question by the special remains of early man and his work, which have been dug up in addition to the piles and brushwood floor, for there are not many. The explorers have not met with anything of great interest in this connection during their recent work, to make the laborious task of examining every individual spadeful more pleasant. Perhaps the most valuable find was a beaver's jaw, though the remains of domestic animals, and shells of oysters used for food, continually cropped up. A deposit of land and fresh-water

shells, also chanced upon, may possibly yield interesting records. The dwelling ante-dates the Roman occupation of Britain, but does not seem to go back further than Celtic times. The piles are accurately sharpened by bevels on four sides, and the tops are occasionally squared. Excepting that the workmanship is less primitive, the Hedsor settlement seems to be constructed on the same plan as that at Braintree (the first inhabitants traced here were certainly Neolithic men), for the piles cannot be made to correspond with any supposed individual dwellings, and were driven into the mud to hold in position, apparently, an artificial island, with a floor of branches and earth raised above the water on which the huts were built. Only a small watercourse (Blessing's Ditch), which runs through the site, marks the direction once taken by a larger tributary of the Thames that now flows into the river higher up. Its waters must in olden times have surrounded the settlement, and the causeway leading from the latter to the dry land has been followed for some distance.

The arrangement of a collection illustrating the modifications of animals that have followed upon domestication has been begun at the British Museum (Natural History), and already a number of interesting stuffed specimens and skeletons have been placed on exhibition in the gallery of British zoology. These include several celebrated dogs, such as the greyhound "Fullerton," as well as a series of South American sheep with four or more horns.

We notice that Mr. J. H. Steward, the well-known optician, has just put upon the market a very elegant and effective equatorial telescope suitable for amateurs, at a price within the reach of all earnest students of celestial objects. Lightness and ease of manipulation are secured without sacrifice of rigidity—a quality which all practical workers can fully appreciate without further amplification. The motion in right ascension is controlled from the eye-end by means of a long handle provided with a Hook's joint, and the clamp for the declination axis is also worked from the eye-end of the telescope. By means of a vernier the declination of an object can be read to five minutes of arc, and the hour circle to twenty seconds.

Dr. Ross, who was sent out to Sierra Leone by the Liverpool School of Tropical Diseases, to trace the cause of malaria, says in a letter:—"For many scientific reasons we have come to the conclusion that the truly malarial fever is caused here solely by the mosquito—probably entirely by the *Anopheles* species. We estimate, then, that most of the malarial fever here can be got rid of at almost no cost, except of a little energy on the part of the local authorities." Perhaps the most encouraging part of Dr. Ross' letter is that in which he says the destruction of the peccant insects, in the puddles in which they spend their larval stage, can be effected by an agent so comparatively harmless as kerosine. For a history of the relations between mosquitoes and malaria, we may refer the reader to an article by Mr. Percy H. Grimshaw, printed in the March, 1899, number of KNOWLEDGE.

RECENT WORK OF THE UNITED STATES BIOLOGICAL SURVEY.

By WILFRED MARK WEBB, F.L.S.

NATURALISTS are beginning to look forward to the interesting as well as useful researches made from time to time by the Biological Survey of the United States. The survey forms a division of the Department of Agriculture, whose year-book has been recently issued. In this volume, among many valuable papers, we find several contributions from biologists.

The first one that we will mention has the title of "Birds as Weed Destroyers," and is written by Dr. Judd, who, it will be remembered, so well weighed the evidence for and against the usefulness of shrikes. Of particular interest is it to us in view of the many attacks upon the character of the English sparrow to hear what this impartial judge has to say about the members of this species, now so thoroughly established in the United States. Dr. Judd says with regard to the native American sparrows that they have been collected in practically all the States, in the district of Columbia, and in Canada. Their stomachs, to the number of four thousand, were examined previous to the writing of his paper, and it was shown that during the colder half of the year the food of these birds is practically made up of the seeds of weeds.

This would lend considerable support to the general idea that the native sparrows are useful, while the English one, seeing that it drives the others away, might for that alone be reasonably regarded as a pest. Now as to the other charges against *Passer domesticus*. A number of birds, including five specimens of our and nineteen of the American sparrows, were collected in a cornfield. All the former were gorged with wheat, while only two of the latter had touched the corn, and then had only partaken of a single grain in each case.

Still, Dr. Judd has a good word to say even for the English sparrows, for they destroy large quantities of weed seeds. He says that they come in thousands to the lawns of the Department of Agriculture, and feed on the grains of two useless grasses which crowd out the ones better adapted for making turf. We are also glad to hear that they make many a meal of dandelion fruits.

Several native birds, such as the song sparrow (*Melospiza fasciata*), the chipping sparrow (*Spizella socialis*), and the white-throated sparrow (*Zonotrichia albicollis*), help the English species in his work of destruction. They usually, however, leave the hardest part of the task to him, and do not open the heads themselves, but seize the exposed fruits or pick up those which have been dropped by their cousins. The latter adopt the following method of securing their food:—Several of the green outer bracts are removed by being cut through close to the swollen part of the stalk or receptacle to which they are attached. The heads selected are those from which the yellow strap-shaped corollas of the florets have disappeared, while from the closed protective bracts, the down-like calices project that ultimately would spread out and form the miniature parachutes that carry away the one-seeded fruits on the wings of the wind. The removal of the casing exposes the down, and below this the fruits; a mouthful of the last is seized by the bird, who separates the down from them by a movement of his beak and swallows them. When a bird is hungry, however, it may not pause to remove the downy tufts, and these are eaten too.

To return to the native birds, although a song sparrow in captivity was able to secure the fruits in the same way as its English relative, yet, as mentioned previously, in a wild state it does not take this trouble. The goldfinch (*Astragalinus tristis*) has a different plan; it waits until a head is ripened sufficiently to open once more, and alighting upon the stem of the latter the bird moves towards it so that it is bent down to the ground, as shown in a pretty vignette. In this position a meal is easily obtained. Prof. Beal, after careful observation in the Upper Mississippi Valley, says that the tree sparrow (*Spizella monticola*) must eat at least a quarter of an ounce of weed seed per

day during the winter. Following this up with a calculation of the number of birds to the square mile, it works out that one million seven hundred and fifty thousand pounds, or eight hundred and seventy-five tons, of weed seeds are destroyed in a single winter in the State of Iowa alone.

Another direct piece of evidence in favour of the usefulness of birds was obtained on a farm in Maryland. Here, in December, a number of sparrows of species whose common names we have already mentioned, together with juncos (*Junco hyemalis*), fox sparrows (*Passerella iliaca*), and whitethroats occurred in positive swarms. They paid particular attention, when feeding, to the tangles of smartweed, and towards the Spring the ground under a particular thicket, some three feet high, was examined. The surface of the soil was quite black with seeds, but these were found to have been split open and emptied of their contents. In a patch eighteen inches square, one thousand one hundred and thirty half-seeds were obtained, but only two whole ones had escaped the birds.

Summing up the matter, it may be said that some fifty species of birds help in destroying the seeds of more than sixty kinds of weeds. Among these are reckoned the blackbirds and their allies as a set-off to their grain-stealing habits. The palm is given to the numerous species included under the heading of sparrows, who, Dr. Judd says, "are little weeders whose work is seldom noted but always felt."

Another paper of interest, dealing with the dangers of introducing noxious animals (mammals) and birds, is by Mr. T. S. Palmer, also of the Biological Survey. Here it is laid down that sometimes the acclimatization of animals has not been followed by such useful results, ultimately, as that of plants, for as a rule the latter are for cultivation, and, consequently, kept within bounds, whereas the animals are set free under conditions that are the nearest possible to their natural environment. Occasionally a garden plant may "escape" and multiply until it is reckoned an objectionable weed, or a wild one may accidentally become introduced with the same result, but the rule holds good. How even a valuable domestic animal may run wild, and cause serious damage, is illustrated by the case of the horse in Australia and the Western States of America. Indeed, in 1897, a law was passed in Nevada to authorize the shooting of wild horses.

The way in which the goats, introduced into the beautifully wooded island of St. Helena in 1513, had converted it into a howling wilderness by 1810, carries with it the mournful remembrance of plants and the animals dependent upon them reduced to extinction that no naturalist likes to dwell upon. We will only mention that it costs the Government some £3000 a year to import fuel for their own use. The introduction of carnivorous animals like cats directly kills off many forms that are not prepared for such an attack in places like oceanic islands where there is no escape.

Next we are given an interesting history of the invasion of the common brown rat, with the dates of its introduction into various countries. Its original habitat is said, upon the authority of Dr. Blandford, to be Chinese Mongolia. The case of the rabbits at the Antipodes is too well known for us to dwell upon, but it might be worth while considering the remedy, which seems to be worse than the evil. Ferrets have been liberated in thousands, together with weasels and stoats, to keep the numbers of the rabbits down, but the two wild species in particular have not confined their attentions to the rodents, but have diminished the number of game birds, and brought many of the interesting local birds to the verge of extinction.

A similar state of affairs has resulted from the turning out of the mongoose in Jamaica to exterminate the rats infesting and damaging the sugar-cane crops. In 1872, four males and five females were imported. In 1882 the saving to the sugar planters was estimated at forty-five thousand pounds. As the rats became scarcer a sad state of affairs began to come to pass. Domesticated animals, particularly young ones, were destroyed continually, the native mammals and birds, as well as snakes, lizards, and other insect-eating creatures, fell a prey to the mongooses, and by-and-by a plague of ticks and swarms of noxious insects filled the island. Even fruits did not escape being eaten by the mongooses when animal food failed. At the present time, however, the carnivorous foreigners are less numerous, but greater loss by far resulted from their acclimatization than if they had never been brought to stay the ravages of the rats.

In the Hawaiian Islands the same beast did much the same things, and when an unfounded rumour of its proposed introduction into the United States by the Department of Agriculture got about, many who knew its history elsewhere raised a great outcry, while others in ignorance made arrangements for the introduction of specimens which through strenuous efforts was prevented from being carried out. Stringent measures of recent years have alone prevented the importation into California of the fruit-eating bat, or flying fox, which is one of the greatest pests of the fruit growers, and threatens their industry with destruction in a great part of Australia. There seems to be considerable danger of the creature getting a hold in the Sandwich Islands if the matter be not carefully looked after.

Coming to birds, Mr. Palmer gives a map showing the distribution of the English sparrow in the United States, and the colonies it had formed in 1860, 1870, and 1886, from which it has still further spread. The old crimes of damaging fruit and grain, of becoming a nuisance in cities, and replacing native birds, are laid once more at its door, without any redeeming features such as were given in the paper previously considered. Its marvellous adaptability is shown by the number of places throughout the world where the sparrow is now established.

The starling has to be given the credit of destroying insects in this country, but with change of scene comes change of habits, and in New Zealand we find our friend with omnivorous rather than insectivorous propensities. The Government of New South Wales, after careful consideration, came to the conclusion to prohibit the importation of starlings into their territory, as they have done that of other creatures harmful to the agriculturalist, by means of a special law.

A contrast is drawn between this arrangement and the unrestricted introduction of all forms of life into the United States. We see, too, from the paper under discussion, as well as from others in the year-book, how quickly attention is turned by the various divisions to the possibilities of the new possessions of America, and again it is emphasized that the mongoose must not be allowed to reach the mainland from Hawaii or Puerto Rico, nor must the fruit-eating bat be permitted to obtain an entry into the first of these places from Australia.

Notices of Books.

A List of British Birds belonging to the Humber District. By John Cordeaux, J.P., F.R.G.S., M.B.O.U. (Porter.) 2s. 6d. net. Just before his much lamented death Mr. Cordeaux published the above list of the birds of his district. This district, which may be roughly described as the land and sea

surrounding the mouth of the Humber, is a very remarkable one ornithologically. Mr. Cordeaux's list includes the extraordinary number of three hundred and twenty-two different species of birds identified as having occurred there. A number of these are "accidental visitors" which have been recognised but once or twice, while a large number of them are "periodical visitors" which pass through this favoured district twice a year. The pamphlet will be invaluable to all ornithologists, not merely as a list, but also for its information regarding times, seasons, and extent of migrations, calculated from the notes for which the author was so famous, and which extended over thirty-five years, and for its accurate details and references concerning the rare visitors which have been recorded for the district.

Telephones, their Construction and Fitting. By F. C. Allsop. (London: Spon.) Illustrated. 3s. 6d. In handling this, the fifth edition of Mr. Allsop's book, we have that pleasant feeling as of meeting an old friend. There is certainly no book concerning telephones—in the English language—which is so thoroughly popular or so eminently practical. Note in this connection the opening sentence: "A telephone instrument consists essentially of three parts—." It should of course be remembered that the work is intended for readers who consider it more important to know "how" than to know "why," so that we have no right to criticise the author's English. We note, p. 23, that the word "caking" is substituted for the more usual expression "packing." And on p. 32 there is a somewhat narrow statement which reads: "An induced current is always of higher E.M.F. than the inducing current." The action of the "armature shunt" (usually so great a stumbling block to the tyro) is explained with wonderful clearness. A little later on we are sorry to see (p. 55) diagrams which show the contacts with their conventional lettering. This seems to imply that there is no need for brain power on the part of persons making the connections. The notes on intercommunication systems are good, and published for the first time in this edition. Going further, under the heading "batteries," we find a vicious suggestion made, to the effect that it may sometimes be advisable to knock a hole in the bottom of the porous pot. And there is in this section, too, that oft-repeated error which makes the E.M.F. of the Leclanche out to be higher than it actually is. Also we note that the B.W.G. is adhered to throughout, instead of, as one would expect, the more modern "standard" gauge being used. On p. 165 there is a statement which, in the light of recent events, should form unpleasant reading for the directors of the National Telephone Co. On p. 169, "section No. 2, the wires 3, 4, and 5," should read "section No. 2, the wires 4, 5, 6." But all the faults we have succeeded in finding are scarcely more than trivialities, and Mr. Allsop deserves hearty congratulation.

Haunts and Hobbies of an Indian Official. By Mark Thornhill. Murray.) 6s. A volume of entertaining reading has been compiled under the above title by a retired officer from a diary kept in India many years ago. The diary contained observations on birds, insects, and animals, as well as memoranda on the weather, notes of interviews with native visitors, and all sorts of information peculiar to India and its people. The author draws a vivid picture of his own quiet life; describes his house, and the arrangement of the rooms; gives an account of his office; and introduces notices of native habits, institutions, superstitions, and weird stories coming within his own experience. Although the author declares his "observations are quite unscientific," he, nevertheless, writes with a lucidity and a power of marshalling a heterogeneous multitude of facts quite beyond the attainments, in this direction, of many who occupy lofty positions in the world of science. As a book of popular information, gleaned by an European official in the plains of India, we can, with assurance, recommend it, both for the diversion of fireside travellers, and those who, for practical purposes, desire to acquire sound knowledge of the country and its inhabitants through a pleasant medium.

A Select Bibliography of Chemistry, 1492–1897. First supplement. By Henry Carington Bolton. (Smithsonian Institution.) This octavo volume of about five hundred pages is a continuation of the chief work, published in 1893. It brings the literature of chemistry down to the close of the year 1897. Works on chemistry—using the term in its broadest significance—are grouped:—(1) Bibliography; (2) Dictionaries; (3) History; (4) Biography; (5) Chemistry, pure and applied; (6) Periodicals; and (7) Alchemy. The last-named section is confined to the original volume, as might have been expected, seeing that it is a sort of dead language in our time. To give some idea of the extent of chemical literature, we may here mention that the number of titles in the present volume is five thousand five hundred and fifty-four, and in the first volume twelve thousand and thirty-one, making a grand total in the two volumes of seventeen thousand five hundred and eighty-five! Here is a marvellous resurrection: a gathering together of the dry bones, so to speak, of old books for five hundred years past, and interesting chiefly to one class of students—the chemists. Although they may never be found accessible under one roof, it is gratifying to know that most of them may be consulted in our national collection at the British Museum.

A Short History of the Progress of Scientific Chemistry in Our Own Times. By Prof. W. A. Tilden, F.R.S. (Longmans.) 5s. net. To the student of chemistry, and to the general reader, this volume will be of deep interest. It contains a concise statement of the present position of chemical knowledge, and a clear account of advances made during the past sixty years. Among the subjects, of which the modern developments are traced, are—thermo-chemistry, atomic theory, the periodic law and dissociation, valency, synthetical chemistry, stereo-chemistry, chemical affinity, and the liquefaction of gases. So far as we are aware, no other volume exists in which the growth of knowledge around each of these cardinal principles and divisions is dealt with distinct from the general history of chemistry. Honours students of the Department of Science and Art should find the volume particularly helpful.

Physics: Experimental and Theoretical. Vol. I. Mechanics, Hydrostatics, Pneumatics, Heat, and Acoustics. By R. H. Jude, D.Sc., M.A. (Chapman & Hall.) Dr. Jude originally intended simply to translate Prof. Gossin's well-known "Cours de Physique," but a consideration of the differences in the requirements of British students preparing for examinations in physical science led him to decide upon certain additions to, and modifications of, the French treatise. The sections dealing with heat and sound have been largely re-written and very much amplified in the present volume, while the earlier chapters remain in much the same form as the original. The final result is not altogether satisfactory, and the inequality of treatment will, we fear, prove very misleading to students. The first two hundred pages or so of the volume supply a popular and more or less introductory account of the leading principles of mechanics, hydrostatics, and pneumatics, of much the same kind as is to be found in the older books based upon Ganot and Deschanel. The laws of heat, on the contrary, are treated much more exhaustively, including as they do a mathematical exposition of thermo-dynamics, which, for its intelligent appreciation, requires a knowledge of fairly high mathematics, and leads the student as far as the study of entropy and Van der Waal's theorem. The volume is, on the whole, well illustrated, though why Dr. Jude permitted the introduction of the roughest of rough sketches on pages 173 and 175 we are at a loss to imagine. And why is there no index? One of the chief uses to which the work was likely to be put is that of a reference book in the numerous schools of science which have lately grown up, but in its present incomplete form it cannot be used for this purpose. But in spite of these deficiencies, Dr. Jude is too good a teacher to produce an altogether second-rate book. His style is clear and lucid, and we have no doubt that many students will read the volume with interest and advantage. Our only regret is that the inattention to the accessory matters which we have mentioned detracts so much from the value of a careful and extensive piece of labour.

Stars and Telescopes. A Handbook of Popular Astronomy. Founded on the Ninth Edition of Lynn's Celestial Motions. By David P. Todd. (Boston: Little, Brown and Company. 1899.) Mr. Lynn is known throughout the astronomical world for his miniature volumes dealing with "Remarkable Comets," and "Eclipses," and the "Celestial Motions." Taking the last-named volume as a basis, Prof. David Todd has expanded it into a most valuable compendium of what are the principal facts of astronomy known at the present day. Although professedly based on Mr. Lynn's earlier work, "Stars and Telescopes" is a new creation, and bears the stamp of original treatment that Prof. Todd seems able to impress on all the books he issues.

It is impossible to give a detailed review of such a book, but we desire to draw attention to one feature, that of itself alone would render the volume an invaluable contribution to astronomical literature. This is the bibliographical appendix to each chapter and section, giving full references to all the principal books, magazines and papers which contain information bearing upon the subject treated. The illustrations are numerous, have reference both to celestial bodies and to bodies terrestrial, and are nearly all new.

Funafuti: or Three Months on a Remote Coral Island. By Mrs. Edgeworth David. (Murray.) Illustrated. 12s. As far back as 1842, when Darwin enunciated his hypothesis on the origin of *coral reefs and atolls*, a lively interest in the structure and distribution of these curious formations began to be displayed by students of Nature. Funafuti is an atoll about twelve miles from north to south, and eight miles in greatest breadth. Mrs. Edgeworth David, who accompanied her husband to the island, here gives an account of the 1897 Funafuti coral-boring expedition, and a charming account it is, not particularly of the scientific operations conducted by her husband and others, but of the inhabitants of this far-away little isle in the Pacific Ocean—manners and customs of the people, amusements, morals, superstitions, and so on. She expresses "a faint hope that this book will enlist sympathy for the Funafutians, and, perhaps, be indirectly the cause of securing a medical missionary for the island." Excepting some oblique efforts at punning—hollow jokes like nuts without kernels—the book forms a fair chapter in ethnography.

Practical Zoology. By the late A. Milnes Marshall, F.R.S., and the late C. Herbert Hurst, PH.D. Fifth edition. Revised F. W. Gamble, M.SC. (Smith, Elder & Co) Illustrated. In the new edition of this well-known work, Mr. Gamble has "thought it well to recast the chapters on technique, and to adopt many of the alterations and additions which have been suggested by a constant use of the last (1895) edition." In other respects no new matter involving a change in the plan of the work has been added. A book of this kind, which has survived four previous editions, scarcely needs the impetus of a Press notice to impart to it a new lease of life. The animals selected for detailed study include characteristic representatives of the more important great groups, and a conscientious worker who follows the lucid instructions here given will acquire a good insight into the leading features of animal structure, and a sound basis of the principal methods of research. Beginning with the amoeba and hydra, and ending with the rabbit and pigeon, it will be seen that the authors take the opposite course to that advocated by the late Prof. Huxley—a course which, ascending from the simple to the more and more complex, is now regarded by most zoologists as being more easy and rational. Some very useful and necessary information is given in an appendix on reagents for killing, hardening, and preserving specimens; staining, clearing, and mounting media; injection fluids, and cements for fixing down sections cut in paraffin. The illustrations, rather sparse, are clear—too clear, in a sense, for sections in flesh and blood, and look so hard, cold, and symmetrical as to give one the idea that they had been reproduced from wooden models.

Bacon or Shakespeare? An Historical Enquiry. By E. Marriott. (Elliot Stock.) 1s. Miss Marriott is a loyal Shakespearian, who has here compiled a lucid and interesting statement of the case against Bacon. We fear the confirmed Baconian, impervious to the facts, is quite beyond the reach of argument, but Miss Marriott's closely-reasoned work may be heartily commended to anyone who feels in need of a fair and comprehensive survey of an exhausted controversy.

Wonders of the Bird World. By R. Bowdler Sharpe, LL.D., F.L.S. (Wells, Gardner, Darton & Co.) Illustrated. 6s. Dr. Sharpe has here put together the lectures on birds which he has been in the habit of giving for the last ten years. The book is written in quite a popular style, and is very pleasant and instructive reading. Dr. Sharpe has chosen a good and inexhaustible subject. Among the chapter headings we may note: Decoration in Birds, Playing Grounds of Birds, Wonderful Nests, Courtship and Dancing of Birds, Parasitic Birds, and Migration of Birds. Dr. Sharpe quotes innumerable authors and field naturalists for his facts, which are detailed and commented upon in a very interesting manner. A few of the stories told, however, can hardly be considered as anything more than "yarns," and we think the author would have done well to have omitted them in his book, though they, no doubt, were well received in his lectures. Altogether the book is very entertaining.

Truth and Error, or the Science of Intellection. By J. W. Powell. (Kegan Paul.) 9s. An attempt is here made to set forth the origin and history of fundamental fallacies. The failure to distinguish between properties and qualities, it is alleged, is the rock on which modern metaphysicians are wrecked. Our author says—"The war of philosophy is between idealists and materialists. The philosophy here presented is neither idealism nor materialism; I would fain call it the philosophy of science." Whatever name it is labelled with, however, the work will remain unattractive. It lacks the requisite continuity and sequence to enable the reader to follow the reasoning clearly. Molecules, stars, stones, and plants, we are told, do not think; only animals have minds; plants do not have minds, but their particles have judgments as consciousness and choice which are developed into psychic faculties only by the organization of animate bodies. The total result of the work does not, we think, strengthen the foundations of philosophy, but it is rather a shifting from one slough into another.

Early Chapters in Science. By Mrs. W. Awdry, edited by Prof. W. F. Barrett. (Murray.) Illustrated. 6s. If accurate information, vouched for by learned professors, constitutes acceptable credentials for the reception of a new book, then Mrs. Awdry's volume should be welcomed by those who desire to know a little of the procession of life and unfolding of phenomena which it is the business of science to arrange in an orderly sequence. Many of the staff of the Royal College of Science, Dublin, have seconded what the authoress has to say on the World of Life and the World of Experiment—a dissertation of very wide scope, indeed, and Prof. Barrett says of the book, "whilst more elementary and not covering so wide a field as M. Paul Bert's volume, it is written in a more attractive style, and avoids the kind of scientific 'pemmican' which characterises M. Bert's volume, and which must be to young people so indigestible, and favourable to mere cram." If, however, one receives too much mental food in M. Bert's book, the reader in the volume before us gets only the smell, as it were, of his intellectual fare, and, in our humble opinion, not a very pungent or appetising smell. The several sections are too laconic to form a useful introduction to general science. We will not challenge the accuracy, but we venture to observe that in these days when School Boards and County Councils are disseminating science broadcast, the need for such books as this is at a minimum, more particularly as it can only be regarded as a primer which, to reach its proper constituency, should have been published at sixpence or a shilling.

True Tales of the Insects. By L. N. Badenoch. (Chapman & Hall.) Illustrated. The title of this work is somewhat misleading. One would expect, from the all-embracing "The Insects," a very comprehensive discourse, whereas the contrary is the truth. The book in reality consists of a few essays, some of which have appeared in serials, and as short articles for illustrated magazines. The matter and style are very appropriate, but we are not by any means of opinion that the re-publication in such a luxurious form as here presented is a prudent step on the part of the author, or a shrewd venture by the publishers. Setting aside a little individuality in the manner of treatment, which is very attractive in places, there is little or nothing new about the insects dealt with, and a considerable portion of the matter is too sketchy to add to the value of the volume—a mere skeleton at the best. Great pains have been taken to impart a good effect to the illustrations from an artist's point of view, but this result has been obtained at the sacrifice of much loss of detail according to the practical entomologist's way of representing insect structure.

Siddhánta-Darpana. A Treatise on Astronomy. By Mahámahopádhyáya Sámanta Sri Chandrasekhara Simha. Edited with an introduction by Jogés Chandra Ráy, M.A., Professor of Physical Science, Cuttack College. (Calcutta, 1897). Of all the numerous works on astronomy that have been published within the last few years, this is by far the most extraordinary, and in some respects the most instructive. It is written in Sanskrit by a Hindu of good family of Khandapárá in Orissa, and is a complete system of astronomy founded upon naked eye observations only, and these made for the most part with instruments devised and constructed by the writer himself. Those who read the sixty pages of the introduction in English, which the

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fellow-countryman of the author, Prof. Chandra Ráy, of Cuttack College, has written, will certainly regret that the barrier of an unknown tongue debars them from a more intimate acquaintance with the very striking personality that Prof. Ráy describes. The work to which Chandrasekhara has devoted himself, and which he has carried out with very conspicuous success is this: The native Hindu almanacs computed from the Siddhántas were falling into serious error, and no two current almanacs agreed in their computations. Chandrasekhara, therefore, has re-determined the elements of the old Siddhánta, but has rigorously confined himself to the ancient methods, his principal instrument of observation being a tangent-staff, devised by himself, of a thin rod of wood twenty-four digits long, with a cross-piece at right angles to it. With these rude means he has obtained an astonishing degree of accuracy; his values for the inclinations of the orbits of the nearest planets are correct to the nearest minute in almost every instance. The ephemerides computed from his elements are seldom more than a few minutes of arc in error, whilst the Bengali almanac may be in error as much as four degrees. To Hindus, for whom their religious observances are regulated by astronomical configurations, this work by one of themselves, a strict follower of the severest laws of their religion, and conducted throughout solely by traditional Hindu methods, is of the highest importance, as it removes the confusions which had crept into their system, without in the least drawing upon the sources of Western science. But the work is of importance and interest to us Westerns also. It demonstrates the degree of accuracy which was possible in astronomical observation before the invention of the telescope, and it enables us to watch, as it were, one of the astronomers of hoary, forgotten antiquity actually at his work before us to-day.

Observations taken at Dumraon, Behar, India, during the Eclipse of the 22nd January, 1898. By Rev. V. de Campigneulles, S.J. With fourteen plates. (Longmans, Green & Co.: London, New York, and Bombay. 1899.) Amongst the numerous parties organized to observe the late eclipse was one arranged by the Jesuit Fathers of the Western Bengal Mission, who took their station at Dumraon, Behar; and the present volume is the account of their observations by the chief of the expedition, Father De Campigneulles. Both the work itself and the report here given of it reflect the highest credit upon the members of the party and on their director. The instruments at their disposal were but of moderate calibre, but were all, with the exception of one of the photographic cameras, quite successful. The other two cameras each secured fourteen good pictures of the corona, whilst the prismatic camera was also very successful. The grating camera failed to give much result owing to the shortness of the exposures, as it was not driven by clockwork. The volume, which is very attractively got up, is far from being a dull dry report. The account of the eclipse itself is brightly written, and two chapters, on solar physics and the spectroscope in connection with eclipses, set forward the principles of eclipse observation in a clear and sufficiently popular manner without for one moment ceasing to be scientific. The results which the Fathers obtained are then sufficiently discussed, and the concluding chapter reviews the results obtained at other stations. One or two printer's errors have escaped the eye of the proof reader. In particular, we note on page 97, "this green ray could be followed up to some six feet from the lunar disc"—minutes of arc of course being meant.

Results of Rain, River, and Evaporation Observations made in New South Wales, 1897. By H. C. Russell, F.R.S. (Gullick: Sydney.) Illustrated. 3s. 6d. When one inspects a comparatively large volume like this, crowded from beginning to end with dry figures, to obtain which a tremendous amount of work must have been accomplished, the question naturally arises—What is the use of it? In 1897, for example, there were one thousand five hundred and fourteen observers engaged in bringing together the data here given from as many stations; these observations show that the average rainfall over the whole Colony for 1897 was 18·89 inches, whereas in 1887 it was 34·99 inches. As regards the utility of the work, Prof. Russell says—"It is becoming generally recognized . . . that the quality of the soil is by no means the only index of value; it is essential that we know also the character of the rainfall at the place . . . before it can be decided if it will grow wheat, and justify the construction of a railway to it and the settlement of a large population." Maps are given showing the localities where rain gauges are in use, but the average set down is the arithmetical mean of all the stations, so the rain gauge of any spot may not show the average for the district it represents. At any rate, in spite of some drawbacks, Prof. Russell is doing an immense service to meteorological science, and, more particularly, to those engaged in agriculture, as well as intending emigrants to the colony of New South Wales.

The Cambridge Natural History. Insects. Part II. By David Sharp, M.A. (CANTAB.), M.B. (EDIN.), F.R.S. (Macmillan.) 17s. net. Comprehensive in scope, satisfying in treatment, with authoritative text and numerous brilliant illustrations, the volumes on insects in the *Cambridge Natural History* are of the highest merit. The present part concludes the discussion of the *Hymenoptera* (bees, wasps, and ants), and deals with the Orders and Sub-orders not treated in Part I., namely, *Coleoptera* (beetles), *Lepidoptera* (butterflies and moths), *Diptera* (flies), *Aphaniptera* (fleas), *Thysanoptera* (thrips), *Hemiptera* (bugs), and *Anoplura* (lice). To describe the characteristic insects in these Orders in satisfactory detail, without giving undue prominence to any particular Order, is a difficult task, but Dr. Sharp has performed it in a manner which will be approved by most entomologists. It is interesting to notice the numbers of insects of various kinds. Dr. Sharp estimates that there are one thousand five hundred species of bees at present known; eight hundred species of solitary wasps, and five hundred or six hundred of social wasps. The number of species of beetles at present known is about one hundred and fifty thousand, of which three thousand three hundred have been found in Britain, and there are about fifty thousand species of butterflies and moths, and forty thousand species of *Diptera*, or two-winged flies. It is therefore not surprising that much has yet to be learnt concerning the structure and habits of many insects. It would be easy to quote many interesting facts with regard to insect life and intelligence from Dr. Sharp's pages, but we prefer to advise students of natural history to see the volume for themselves. The work is not popular in the sense usually understood, but it contains an account of insects written in the clearest possible language consistent with accuracy and the scientific spirit.

BOOKS RECEIVED.

The Social Life of Scotland in the Eighteenth Century. Two Vols. By Henry Grey Graham. (A. & C. Black.) 24s.

Birkbeck Literary and Scientific Institute Calendar, Session 1899-1900. (Witherby & Co.) 6d.

Natural and Artificial Methods of Ventilation. (Boyle & Son, Limited.)

Elementary Algebra (to Quadratics). By C. H. French and G. Osborn. (Churchill.) 4s. 6d.

Animal Biology. By C. Lloyd Morgan, F.R.S. Third Edition. (Longmans.) Illustrated. 8s. 6d.

The Children's Study—Canada. By J. N. McIlwraith. (Unwin.) 2s. 6d.

The International Geography. By H. R. Mill, D.SC. (Newnes.) Illustrated. 15s.

The Pillar of Fire. By Rev. J. H. Ingraham. (Ward, Lock & Co.) 3s. 6d.

The Photo-Miniature. September. (Dawbarn & Ward.) 6d.

Billiards, Mathematically treated. By G. W. Hemming, Q.C. (Macmillan.) 3s. 6d. net.

Heat. For Advanced Students. By Edwin Edser. (Macmillan.) Illustrated. 4s. 6d.

The North American Slime-Moulds. By Thomas H. Macbride. (Macmillan). 10s. net.

Optics. A Manual for Students. By A. S. Percival. (Macmillan.) 10s. net.

Pitman's Shorthand and Typewriting Year-book for 1900. 1s.

Handbook of Optics. By William Norwood Suter, M.D. (Macmillan.)

Practical, Plane, and Solid Geometry. For Advanced Students. By Joseph Harrison and G. A. Banandall. (Macmillan.) 4s. 6d.

Inorganic Chemistry. For Advanced Students. By Sir H. Roscoe and Arthur Harden. (Macmillan.) 4s. 6d.

Matter, Ether, and Motion. By Dr. A. E. Dolbear. (S.P.C.K.) 5s.

London University Guide and University Correspondence Calendar, 1899-1900. Gratis.

Magnetism and Electricity. For Beginners. By H. E. Hadley. (Macmillan.) 2s. 6d.

Elementary Practical Mathematics. By Frank Castle. (Macmillan.) 3s. 6d.

The Story of Ice. By W. A. Brend. (Newnes.) 1s.
Our Secret Friends and Foes. Prof. Percy Faraday Frankland. Fourth Edition. (S.P.C.K.) Illustrated. 3s.
The Latimer Collection of Antiquities from Porto Rico. By Otis T. Mason. (Smithsonian Publications.)
Report of the Chief of the Weather Bureau, 1897—8. (U. S. Department of Agriculture.)
The Studio. October. 1s. (15, Henrietta Street, Covent Garden.)

THE STORY OF THE ORCHIDS.—III.

By the Rev. ALEX. S. WILSON, M.A., B.Sc.

THE most remarkable example of sensitivity among orchids is, however, *Catasetum tridentatum*. The flower is polymorphic, and the three forms were for long referred to distinct genera. All three sorts of flowers are occasionally produced on a single plant. *Monacanthus viridis* is the female, *Myanthes barbata* the hermaphrodite, and *Catasetum tridentatum* the male variety; all three being merely sexual forms of the same flower. The rostellum develops two long slender prongs which protrude from the flower. These antennæ are exceedingly sensitive, and if either of them be touched the impulse is transmitted to the membrane of the rostellum, which covers the glandular disk of the pollinium. This membrane suddenly splits, and the pollinium, which the membrane kept curved in a state of extreme tension, springs up, and tearing itself out of the anther-lobe is projected to a distance of several feet like a stone from a catapult. The pollinium is thrown out in the direction from which the stimulus comes, the sticky disk being foremost; if the cause of the irritation be a bird or large insect the projectile can hardly miss its mark. The ejected pollinia of *Catasetum* have been found sticking on panes of glass in a greenhouse at a distance of several feet from the flowers.

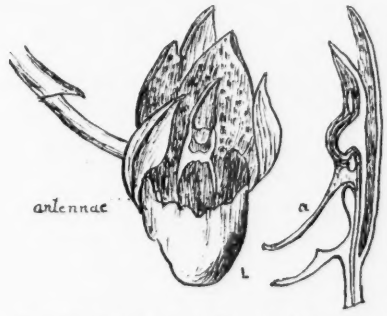


FIG. 8.—*Catasetum*: in Front and Section.

Another extraordinary flower is that of *Coryanthes speciosa*, of Trinidad. The labellum is in the form of a rounded pitcher or bucket, into which drops of sweetened water continually fall from two horn-like projections on the column: over an ounce is collected in this way. When the bucket is full the liquid overflows by a spout at the back. Over the bucket there is an expansion of the labellum (hypochilium), on which certain humble bees congregate; and as they struggle for room, one after another is pushed over into the bucket beneath. With their wings drenched they are unable to fly, and so crawl out by way of the spout in a regular procession. The floral arrangements being similar to those in Cypripedium the stigma is pollinated, and the pollen removed as the visitors emerge from their involuntary bath.

The *ne plus ultra* of adaptation to insects is, however, attained by *Angraecum sesquipedale*, an orchid which grows in the island of Madagascar. Its pale white blossoms have a whip-like nectary over a foot in length. Naturalists confidently predicted that an insect with a proboscis of corresponding length would be discovered, and this was ultimately done by Mr. W. A. Forbes, who visited Madagascar and secured a huge sphinx moth having a tongue which measured eleven inches. More recently, Mr. G. F. Scott-Elliot found sphinx moths with proboscides eighteen inches long. This observer also saw sun-birds visiting the flowers of Angraecum. In Brazil, Fritz Müller caught a hawk moth with a proboscis of eleven inches; analogy would lead one to infer the existence of flowers to correspond. The length of the nectary varies a good deal in different specimens of Angraecum, but those flowers in which it is shorter than the visitor's proboscis are placed at a disadvantage, for the insect can remove their nectar without bringing its head in contact with the rostellum. Natural selection must therefore tend to perpetuate those flowers with the longest nectaries. The forcible ejection of the pollinia in *Catasetum* and *Dendrobium*, already considered, is but another method of securing the same end that is served by the elongated spur of Angraecum.

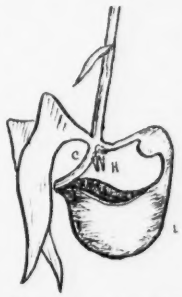


FIG. 9.—*Coryanthes speciosa*. L. Labellum; H. Secreting Horns; C. Column.

Even among British orchids there is a distinct tendency towards adaptation to special insects. This appears even from a general survey, but is much more obvious when the details of their structure are studied. H. Müller has remarked that many species which in the lowlands are specialized in relation to bees, have in the Alps acquired deeper nectaries and become adapted to butterflies, which are more numerous than bees at lofty elevations.

To account for these mutual relationships between orchids and insects would be a comparatively simple matter were we at liberty to make two assumptions—viz., the existence of highly specialized fertilizing agents to begin with; and the superiority of cross-fertilization over self-fertilization. The botanist, in seeking to explain the development of flowers, naturally postulates the requisite variety of insect forms; the zoologist, to account for the differentiated organs of the insects, as naturally postulates a corresponding variety of floral structures. We see, therefore, that these special relationships could only have arisen out of conditions much more simple. Flowers and insects must have become differentiated together. The primitive shallow blossoms and short-lipped visitors would necessarily be in a state of stable equilibrium; in the absence of any means of isolating those flowers and insects in which corresponding variations happened to take place, whatever variations did occur, would tend to neutralize each other and no evolution would be possible. But in this case, as in artificial selection, the element of volition comes in. The instinct and intelligence of the insects themselves leading them to select those flowers which suited them best would, to some extent at

FIG. 10.—*Angraecum sesquipedale.*

least, secure the isolation required, and must, therefore, have played an important part in bringing about these extraordinary co-adaptations. It is held by some that the very complete adaptations in orchids to cross-fertilization could not have been possible but for the long interval that elapses between the pollination of the stigma and the impregnation of the ovule by the pollen-tube. Be this as it may, orchids are exceedingly liable to vary, and therefore furnish abundant materials upon which natural selection can work. But natural selection only comes into operation with favourable variations, and, so far as orchids are concerned, it is by no means certain that variations which favour intercrossing are advantageous. Notwithstanding the wonderful contrivances for facilitating intercrossing, self-fertilization occurs extensively throughout the order. Many of the most abundant orchids habitually fertilize themselves. The fly orchis is even more fertile with its own pollen than when crossed. The structure of some orchids is such as entirely to prevent spontaneous self-fertilization; nevertheless, they are perfectly fertile with their own pollen when artificially fertilized. Henslow will even have it that crossing, so far from being advantageous, is a decided disadvantage to the plants. On this view the first modification of flowers arose from degeneration brought about by the interference of insects. Only when this process had gone so far, and consequent malformations had been produced which rendered self-fertilization difficult or impossible, did the necessity for crossing arise. Not till then could natural selection begin to tell in the production of contrivances for intercrossing. The orchid pollinia result, no doubt, partly from the arrested development of the pollen grains and their mother-cells, but it is hard to believe that such an elaborate structure as the rostellum is merely due to degeneration or arrested development. Even if it could be shown that self-fertilization was more prevalent and effectual than it is, we should have difficulty in accepting the view that the elaborate arrangements in flowers for cross-fertilization have been called into being with no direct or primary reference to the interests of the flowers themselves. While Henslow's explanation is just the inverse of Darwin's, both are probably somewhat one-sided. As the stability of the solar system depends alike on the centrifugal and centripetal forces, so it may be in the organic world. It is conceivable that self-fertilization may be advantageous perhaps in the way of fixing or transmitting acquired characters while cross-fertilization may be beneficial in other directions. Nature at least does not incautiously discard either alternative, but prefers to retain both, fulfilling herself in many ways,

"Lest one good custom should corrupt the world."

The orchids are an exceedingly numerous order, the Compositæ among flowering plants alone excel them in respect of variety. Upwards of eight thousand species are known, of which about forty are British. The bright-coloured kinds are, however, only a small minority; a vast number have comparatively unattractive, valueless flowers. The task of the orchid hunter is by no means easy, he may travel far and incur many risks before he discovers a flower sufficiently attractive to repay cultivation. A collection of tropical orchids awakens in us feelings not unlike those of which we are conscious in visiting a menagerie. These feelings would doubtless vanish could we see the flowers amid their native haunts and natural surroundings. Their strange and grotesque forms appeal to our curiosity; their endless variety of colouring excites our admiration. There is the azure Vanda of the Himalayas, with its great profusion of blossom, a single plant according to Sir Joseph Hooker sometimes bears three hundred or four hundred flowers in one season. Again we have the Dendrobriums with their exquisite contrasts, the Oncidiums with their soft delicate tints, the rich white and crimson hues of the stately Cattleyas, the Lælias, the Cælogynes, the Odontoglossums, and a host of others equal in splendour. Yet, withal, these eccentricities of Nature, beautiful, elegant, and interesting as they are, lack for us that homely grace and charm which the associations of childhood have thrown around the more familiar flowers of our native land.

ON THE DUTY OF A FIELD NATURALIST.

By E. A. S. E.

WANDERINGS amongst the banks and braes, and o'er the billowy ocean and mountain crag have evolved some of the grandest thinkers of the age—Darwin, Owen, Huxley, were all field naturalists of the highest type, and surely all of us are better for their writings.

After all, field naturalist is but a trivial name given to one who, if he be a naturalist at all, is at heart a natural philosopher, seeking amongst the secrets of Nature the evidence of truth. It is for him to "labour and to wait"; full well he feels that—

"Art is long and time is fleeting,
And our hearts, tho' strong and brave,
Still like muffled drums are beating
Funeral marches to the grave."

Who has not felt a thrill of emotion on hearing that harbinger of spring—the cuckoo—for the first time on an April morn, a feeling of thankfulness for having lived to see another year burst forth into promise, or yet when the skylark, springing upwards to the very vault of heaven itself, pours forth its love-inspired song in tuneful ecstasy; or, again, in the solitude of the moorland hills, has not been struck by the impressiveness of the scene—

"Where the fox loves to kennel and buzzard to soar,
All boundless and free o'er the rugged Dartmoor."

It seems incomprehensible that anyone can live in a state of utter indifference to the bountiful gifts of Nature met with on every hand, yet there are those who have a positive dislike for things of the field, whilst as for wishing to know anything about their economy, that passes their wit altogether.

I have been brought more in contact with birds than any other subject of natural history, so I naturally turn to them for an expression of my thoughts, and, singularly enough, it is to be found in their nomenclature. Many of these names were given by one of the greatest field naturalists who ever lived—Linnæus, and so we often get summed up in one little Latin or Greek word the chief characteristic of the species, simply because of his observations in the field. For instance, *Cælebs*, a bachelor, is the specific name given to the Chaffinch because the males flock together in the autumn and keep separately from the females until pairing time comes again.

The genus *Phylloscopus* (from φύλλον, a leaf, and σκοπέω, I look at) derives its name from the habit these little warblers have of searching amongst the foliage for the tiny insects they feed on. The Great Grey Shrike (*Lanius excubitor*) indicates the bird's habits to a nicety. *Lanius*, a butcher, and *excubitor*, a sentinel or watchman, from this bird's habit of perching on the topmost twig of a bush on the look-out either for prey to butcher and impale, or an enemy to avoid. The genus *Lagopus* derives its name from the fact that the legs of the grouse by their complete covering (in winter) of short hair-like feathers resemble those of a hare (*Lagopus*, λαγωπούς, from λαγώς,

a hare, and πούς, a foot). The Rose-coloured Starling owes its name, *Pastor roseus*, to the fact of its following in the tracks and even perching on the backs of cattle or sheep in search of grubs: (*Pastor*, a shepherd). This trait is again exemplified in the Buff-backed Heron (*Ardea bubulcus*), (*bubulcus*, a herdsman).

The Wrens, again, owe their name *Troglodytes* from the fact of their building a domed nest. *Troglodytes*, τρωγλοδύτης, one who lives in holes.

The Golden Plover was given its specific name *Pluvialis* (rainy) because it was supposed to become more restless and noisy on the advent of wet weather, not because it frequented marshy places. The Dotterel obtains its specific name, *Morinellus*, dim. of *Morus* (μωρός, a simpleton), because the bird on the approach of the fowler was said to imitate his gestures, stretching out a wing when he did an arm, etc., but this habit is not an imitative one, and is common to all the *Charadriidæ*, to which this species is allied. At the same time the Dotterel is a very simple bird, and easy of approach, so that the name still holds good. The Common Snipe owes its specific name *Cœlestis* (belonging to heaven) from the habit of the male, which during the breeding season is continually rising with rapid beat of wing far into the skies.

The Barn Owl (*Strix flammea*) owes its generic name to στρίξ, from the root of τρίζω (I cry sharply or shrilly), and we find a word derived from *Strix* used in mediæval times of peculiar significance, when so many poor wretches were tortured and put to death under the impression they were persons of ill-omen—namely, *Strigia*, a witch or hag.

Turnstone, as well as the scientific name of the bird (*Strepsilas interpres*), denotes its habits, *Strepsilas* being derived from στρέφω (I turn), and λᾶς (a stone). *Interpres* is stated to have been given by Linnæus because this bird is a warner or explainer to other waders, but the Turnstone is a peculiarly silent bird, and I think the great naturalist used the word in its broadest sense—that is, meaning a go-between, or broker; one who gets his living between two persons or things. This puts me in mind of another specific name of interest, namely, that of the Fieldfare. The specific name, as we have it, of the Fieldfare is *pilaris* (a ball). Now there is nothing characteristic in the spots on the breast of the Fieldfare; they are common to all the Thrush tribe. We find *pilaris*, the translation given by Gaza (1476) of τρῖχάς (a kind of Thrush), in Aristotle, Hist. An. IX., 20, as if that name were derived from θριξ (*Pilus*, a hair), and *os* (*oris*, a mouth, which might refer to the rictal bristles); but here, again, we have the difficulty that this is a characteristic of all the *Turdidæ*, and the Fieldfare is not the type of the Thrushes. Can it be that the word meant is *pileus* (πῖλος, a felt cap or hat made to fit close, and shaped like the half of an egg—a cap worn by the Romans at entertainments and festivals)? The grey crown of the Fieldfare in breeding plumage so exactly suits this description.

Nothing can be turned to better account than the interpretation of the specific name of the Cirl Bunting (*Emberiza cirlus*). *Cirlus*, like the German *Zirl-ammer*, is from the Italian *Zirlare* (to chirp, to cry "zi, zi"). The bird is called *Zizi* by the Piedmontese, the note of the male-bird being exactly interpreted by this sound, and one's attention in spring is instantly arrested by its constant repetition from some conspicuous twig which is favoured by the bird.

The Flycatchers (*Muscicapa*) again obviously take their name from their habit of obtaining food: *Muscicapa*, from *musca*, a fly, and *capio*, I catch.

The generic of the Ringed Plovers, *Aegialitis* (ἀιγιαλιτης, a dweller by the sea-shore), has a deeper meaning than its literal one, for the derivation ἀιγιαλεύς referred in heathen mythology to the brother who was cut to pieces, and whose remains were scattered along the sea-shore by his sister Medea. Everyone who knows the habits of these birds, how the flock, on dropping down, after a wheeling flight, radiate and spread out all over the sands, can appreciate the appropriateness of the synonym, the habit being in marked contrast to those of the Sanderling (*Calidris arenaria*), which in little compact flocks advance and retreat with each ebb and flow of wave with surprising regularity and nimbleness.

Other birds, again, are named with reference to distinctive marks of colour in the feathers or soft parts, such as the bill or legs, as the Black-throated Thrush (*Turdus atrigularis*), *atrigularis* from *atri*, black, and *gula*, a throat. The Twite (*Linota flavirostra*), *flavirostra* from *flavus*, yellow, and *rostrum*, a beak; in fact this bird is known as the yellow-nebbed lintie in North Britain. The Golden Oriole (*Oriolus galbula*), *Oriolus* from *Aureolus*, golden, *galbula*, a yellow bird, the sight of which was supposed to cure jaundice, though the bird died. The Harlequin Duck (*Cosmonetta histrionica*), *Cosmonetta* from κόσμος, ornament, and νῆττα, a duck; from its brilliantly contrasted plumage: *histrionica*, belonging to or like an actor.

It is interesting to note how this peculiarly beautiful style of plumage takes the popular fancy. A handsome little Quail (*Cyrtonyx montezuma*) of America is known to the miners of Lower California and Arizona as the Fool Quail, for the reason that its plumage is spotted and striped in strong contrast. The Green Sandpiper (*Totanus ochropus*), *ochropus* from ὠχρος, pale yellow, and πούς, a foot.

Again, some abnormality of structure has called forth attention, and a name given to emphasize the fact, such as Pallas's Sand Grouse (*Syrrhaptes paradoxus*), *Syrrhaptes* from συρράπτειν, to sew or stitch together, because the last phalanges of the toes alone are free, all the toes being as it were sewn together like a fingerless glove: *paradoxus*, strange, contrary to expectation, referring of course to the curious structure of foot.

In fact, the nomenclature of birds opens up enough romantic material to fill a four volume novel, and breathes in every line the work of a field naturalist, and yet it merely touches the fringe of one subject in natural history. Let us not, however, be dismayed at the wide field which opens out for investigation; rather let us increase our ranks, and endeavour to instil into others the enthusiasm which is the very essence of our life, and whilst we make truth, keen observation, and sympathy our cardinal principles, let us emulate Longfellow's village blacksmith:—

"Toiling—rejoicing—sorrowing—
Onward through life he goes:
Each morning sees some task begun,
Each evening sees its close:
Something attempted, something done,
Has earned a night's repose."

Microscopy.

By JOHN H. COOKE, F.L.S., F.G.S.

The embedding of lichens is, at best, a delicate operation. Prof. G. F. Pierce, of Stanford University, California, has devoted some attention to this phase of microscopical technique, and recommends a mixture of hard and soft paraffin, which melts at about 60° C., as a satisfactory medium. After fixing the material, small pieces of the paraffin are added to the pure xytol, in which the material has already been cleared, and the dish is kept warm, both to increase the solvent power of the

xytol, and also finally to evaporate it all. The material is thus slowly warmed and penetrated with paraffin, and is left for about three hours after the xytol has all evaporated. The sections should be very thin, and, before cutting, the block should be chilled to somewhat below 20° C. Staining on the slides by any of the usual methods is easy, and the results satisfactory.

The fugitive character of staining effected by aniline colours has led E. Van Ermengem to devise the following process for staining the cilia of bacteria. It is founded on the reduction of silver from a solution of its nitrate. The bacteria films are well dried, and immersed in a fixing bath consisting of osmic acid (two per cent.) one part, and tannin (ten per cent.) two parts. They are then washed carefully in water and in alcohol, and passed to a weak solution (·5 per cent.) of silver nitrate. Without further washing, transfer to a bath of gallic acid, five parts; tannin, three parts; sodium acetate, ten parts; and distilled water, three hundred and thirty parts. After a few moments they should be returned to the silver bath, washed thoroughly, dried, and mounted in balsam.

Algæ introduced in small quantities into aquaria containing good aerating plants like myriophyllum, calumba, ranunculus, water mosses, etc., will thrive for long periods, and so furnish the microscopist with a supply of material for use at any time. Freshwater crustaceans, as cypris and cypridospis, may be added with advantage, their functions as scavengers adding considerably to the purity of the water. They are particularly fond of the mesophyll of leaves which they remove, leaving beautiful leaf skeletons.

A bristle from an old shaving brush, when fastened in a wooden handle, makes a useful accessory for selecting foramens, mineral fragments, diatoms, etc. These bristles are nearly always split, and, when pressed on the glass slips, the ends readily separate. The material and slip should be so arranged that the selected object shall occupy a position between the split portions. On removal of the pressure the bristle closes, and the object, being secured, is transferred from one slide to another.

The sectioning of entomostraca and other minute crustaceans offers many difficulties, both on account of the hardness of their chitinous coats as well as of their small size. To overcome these, Dr. Giles suggests the following method, which he has practised with marked success. The animal is taken from absolute alcohol, and clarified in oil of cloves, after which it is placed in a watch-glass containing a few drops of Canada balsam, and gently heated over a spirit lamp. The balsam quickly drives out the clarifying agent, and permeates the tissue of the object, forming round it a hard bead. A single drop of balsam is then placed on a glass slip and heated, until on cooling it becomes quite hard. The bead of balsam containing the object is next propped up on the balsam on the slide, which has been previously warmed, in the position in which it is desired to cut the section. It is necessary that the balsam should be neither too soft nor too brittle. If too soft, it will stick to the razor blade when sectioning; and if too brittle, it will chip away. A few trials before embedding the object will enable the microscopist to estimate the amount of heat that is necessary to reduce the balsam to the requisite consistency. The beauty of the sections obtained by this method will well repay the trouble and care expended.

In the biological laboratories of Denison University, wax-modelling is largely used for demonstrations in the morphological and comparative study of organic structures. The methods employed consist, essentially, in constructing enlarged patterns of a series of microscopic sections, and from these patterns constructing a model which will represent the original unsectioned tissue, but on a greatly enlarged scale. The sectional drawings are traced on wax sheets of uniform thickness by the aid of the camera lucida, or the projection microscope. A porcelain stylus, or an ordinary lead pencil, are equally suitable for the purpose. After outlining the sections on the wax sheets, they are cut out in serial order, either with an ordinary penknife or with a fine, stretched wire. To guard against misplacement in the final reconstruction, each section is given a number which corresponds to that on the drawing, and the whole is cemented together by means of heat. The model is finally glazed over by being held for an instant over a hot flame.

Most petrologists are conversant with the methods employed in the uses of dense liquids for the isolation of the mineral constituents of a rock-mass. Many of the liquids used for this purpose are, however, of a dangerously corrosive and poisonous character, while others are so expensive as to be beyond the reach of the average private student. In the latter category may be placed Klein's solution of boro-tungstate of cadium, a reagent which is essential to the complete equipment of the micro-petrologist. If purchased in the ordinary way, this solution is one of the most expensive. By means of the following method, first suggested by Mr. W. B. Dallas Edwards, its cost of production is very trifling. Dissolve 450 grains of sodium tungstate in as little boiling water as possible, and add slowly 675 grains of boric acid in small crystals. Allow sodium borates to crystallize out by repeated stages and partial evaporations till the sodium boro-tungstate is obtained as a heavy liquid, in which felspar floats. Boil this, and add 150 grains of $BaCl_2$ dissolved in 200 c.c. of water, a little at a time. Wash and collect the precipitate, and add 300 c.c. of ten per cent. HCl. Evaporate to dryness, and add 40 c.c. of HCl. towards the end. Dissolve in 300 c.c. of hot water, and filter off the green tungstic hydrate. Evaporate down till most of the barium boro-tungstate is obtained as light-yellow, lustrous crystals. Re-crystallize, and dissolve in 200 c.c. of water, and add $CdSO_4$ drop by drop. Filter and evaporate to sp. gr. 3·46. On standing some crystals separate, and the sp. gr. falls to 3·28.

Microscopical investigations may be carried on without the operator incurring any risk of injuring his eyesight, provided that the following conditions be strictly observed. Never commence work directly after a meal. Do not use too strong a light. Unmodified sunlight should not be employed, except in special cases. North light is best, and most uniform. To avoid the shadows produced by the hands in manipulating the mirror, it is better to face the light; but when so doing, care should be taken to shade the eyes and the microscope stage. Otherwise endeavour to so arrange the light, whether it be sunlight or artificial, so that the illuminations shall come over the left shoulder, as in reading. And lastly, work at a table of a height such that, when seated, the ocular will be on a level with the eye of the operator. The top of the table should be painted a dead-black.

The "soap mass" is one of the best embedding materials that the student of botany can use for cutting sections of fresh vegetable tissues. A simple and expeditious method of preparing it is as follows. Take good, white, hard soap, cut in very thin slices, and having gently compressed them in a suitable dish, pour in enough (ninety-five per cent.) alcohol to somewhat more than cover them. Heat to near the boiling point of alcohol, until the soap is dissolved. Add now a small quantity of glycerine. The amount of the latter can be readily ascertained by pouring out a few drops of the warm mixture, and allowing it to cool. Without any glycerine the mass instantly congests into a white, friable substance, quite unfit for embedding; but as a proportion is gradually added, the mass hardens less and less rapidly, and becomes more and more transparent. For soft tissues, the mass may be made as transparent as glass; for harder substances, less glycerine must be used.

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

NEW COMET.—A new comet was discovered by M. Giacobini, at Nice, on September 29th. It was situated in R.A. 246° 38′, Dec. 5° 10′ south, and its diurnal motion was 30′ eastward and 10′ northward. The comet is described as faint. At the time of its discovery its position was about 60° east of the sun, so that it set about four hours after that luminary. Elements have been computed by Möller and Giacobini, but they differ considerably. On November 2nd the position of the comet will be in R.A. 17h. 5m. 43s., Dec. N. 4° 26′.

HOLMES'S COMET.—This comet may possibly be seen in very powerful telescopes, but there is a singular dearth of observations of it, and there is little doubt that its extreme faintness has enabled it to escape general notice. In *Ast. Nach.*, 3595, Zwiers

gives an ephemeris of the comet for the last three months of 1899, and from this the following positions are extracted :—

Greenwich Mean Midnight	R.A. α h. m. s.	Dec. δ ° ′ ″	Distance in Millions of Miles.
November 5 ...	2 32 57	+ 49 9 29	154
„ 10 ...	2 27 0	+ 48 54 30	155
„ 30 ...	2 8 59	+ 46 44 50	165
December 10 ...	2 5 1	+ 45 17 38	174
„ 30 ...	2 7 45	+ 42 29 6	196

The comet is travelling away from the earth and becoming fainter. On the evening of November 1st it will be about half a degree N. of the star θ Persei (mag. 4·2).

THE COMET OF THE LEONIDS (Tempel, 1866 I.).—This comet was due to return in the spring months, but its position was very unfavourable, and it has eluded detection. Whenever its perihelion passage occurs in about November or December, the comet can be favourably observed from the earth, but this only takes place once in a century. At the close of 1965, and again at the end of 2065, this interesting object is likely to be presented under the best conditions.

FIREBALL OF AUGUST 27TH, 10H. 13M.—About eight accounts of this object have been received, and they indicate the radiant as situated approximately in 191° + 32°. When first seen the meteor was sixty-eight miles above Wigan, and at its disappearance forty-seven miles above Cambridge. Its length of path was one hundred and forty-three miles, and velocity about twenty-five miles per second.

FIREBALL OF OCTOBER 2ND, 8H. 20M.—A very brilliant and striking meteor was seen by Lieut.-Col. J. P. H. Boileau, A.M.S., at Trowbridge, passing very slowly from Corona Borealis to Ursa Major, where it disappeared below ε on a line drawn from γ to η. Its duration of flight was four or five seconds. Shortly before extinction, the nucleus divided into two very distinct bright stars, one following the other in the same line of motion. The meteor left an evanescent train of white nebulous light. The same object was seen by Mr. M. J. Nyhan, of Bristol, and he recorded its path as from about fifteen degrees below α Lyræ to twelve degrees above ζ Ursæ Majoris. The meteor moved with extraordinary slowness, its whole duration of visibility being estimated as eight seconds. Near the end of its flight the head broke into two portions, which were three-and-a-half degrees asunder when the meteor vanished. The radiant of the meteor was at 284° −17° in the northern region of Sagittarius. Its height was from about sixty-seven to forty-five miles above the English Channel, thirteen miles W.N.W. from Ilfracombe to Knighton, Radnor. Length of path eighty-six miles, and velocity about thirteen miles per second. When the meteor disappeared, the distance between the two fragments into which the nucleus separated was about six miles.

THE EXPECTED LEONID SHOWER.—The moon will be full on the morning of November 17th, and her light will greatly moderate the brilliancy of any display that may occur. If, however, the maximum should take place on the morning of the 15th, just before sunrise, it ought to be well seen, as the moon sets at 4h. 54m. a.m. There will also be a little dark sky on the morning of the 16th after 6h. 13m. a.m. According to Drs. Stoney and Downing the most probable time for the middle of the ensuing shower is the 16th, at 6 a.m., when the moon is near setting, and the display ought to be seen to advantage if the calculations are justified by the event. In 1898 the shower, such as it was, occurred earlier than the time predicted, and in view of the uncertainty prevailing it seems desirable to watch the sky on the mornings of the 15th and 16th. Many attempts will be made to photograph the shower and determine the centre of the radiant from the trails impressed on the plates, so that observers, viewing the shower in the ordinary way, need not concern themselves with this feature. They will probably be more usefully occupied in noting the time of maximum, the number of meteors per minute near and at the period of maximum, and in recording the apparent paths of brilliant Leonids or of large meteors from other showers. If any observer decides upon fixing the place of the radiant this may be done with considerable accuracy by registering the paths near to it, and, for intervals of (say) half-an-hour, getting independent positions for it. The mean of eight or ten well determined places would probably be very accurate and agree very closely with the best positions ascertained by the photographic method. As the radiant of the Leonids does not rise until about 10h. 15m. p.m., observations must not, in any case, be commenced before that hour, and it is rarely that many of the meteors are seen before midnight.

THE FACE OF THE SKY FOR NOVEMBER.

By A. FOWLER, F.R.A.S.

THE SUN.—On the **1st** the Sun rises at 6.56, and sets at 4.32; on the **30th** he rises at 7.43, and sets at 3.54. Few sunspots are likely to be observed.

THE MOON.—The Moon will be new on the **3rd**, at 10.27 A.M.; will enter first quarter on the **10th**, at 1.35 P.M.; will be full on the **17th**, at 10.18 A.M.; and enter last quarter on the **25th**, at 6.35 A.M. The following occultations are the most notable of those occurring during the month :—

Date.	Name.	Magnitude.	Disappearance.	Angle from N.	Angle from V.	Reappearance.	Angle from N.	Angle from V.
Nov. 12	κ Piscium	5·0	11.11 P.M.	136°	104°	11.29 P.M.	170°	137°
„ 17	A^1 Tauri	4·5	10.21 P.M.	54	83	11.29 P.M.	283	296
„ 19	Neptune	...	6.10 P.M.	95	129	7.1 P.M.	261	299

THE PLANETS.—Mercury is an evening star throughout the month, but on account of his great southerly declination he is unfavourably situated for observation in our latitudes. He is at greatest easterly elongation of 22° 18′ on the **16th**, but even then he sets about fifty minutes after the Sun.

Venus is an evening star, but too low and too near the Sun for observation.

Mars, Jupiter, Saturn, and Uranus are also out of range. Jupiter is in conjunction with the Sun on the **13th**, and Uranus on the **30th**.

Neptune remains nearly midway between ζ Tauri and η Geminorum, and is above the horizon practically all night.

THE STARS.—About 9 P.M. at the middle of the month, Gemini will be low in the north-east; Auriga and Perseus high up in the east; Taurus between east and south-east, with Orion below; Aries nearly south-east; Cetus nearly south; Andromeda and Pisces in the south; Cassiopeia almost overhead; Pegasus and Aquarius towards the south-west; Cygnus and Aquila in the west; Lyra a little north of west; Corona setting in the north-west; and Ursa Major towards the north.

Convenient minima of Algol occur on the **2nd** at 5.39 P.M., on the **19th** at 10.32 P.M., and on the **22nd** at 7.21 P.M.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Netherfield, Camberley, and be posted by the 10th of each month.

Solution of October Problem.

Key Move—1. Kt to KB5.

Threat Variation.

2. R to K3ch.

2. . . . P × R, 3. Kt to Q6ch, etc.

2. . . . K to Q4, 3. B to B7ch, etc.

Defence A.

1. . . . K to Q4, 2. R × Pch.
2. . . . K to B5, 3. Kt to Q6ch, etc.
or 2. . . . K to K5, 3. B to B3ch (or Kt to Q6ch).

Defence B.

1. . . . P × P, 2. Q to Q4ch.
2. . . . K × Kt, 3. R to K3, etc.

Defence C.

1. . . . Kt to B7, 2. R to K3ch
2. . . . Kt × R, 3. Kt to Q6ch, etc.

Defence D.

1. . . . B × Kt, 2. R × QP.
2. . . . K × R, 3. Q to B3ch, etc.
or 2. . . . Kt moves, 3. B to B3ch, etc.
or 2. . . . P to B6, 3. B × Pch, etc.
or 2. . . . B to Kt5, 3. B to Kt6ch, etc.

Defence E.

1. . . . P to Q7, 2. R to QB3.
2. . . . P bec. Q, 3. Kt to Q6ch, etc.
or 2. . . . K to Q4, 3. B to B3 mates.
or 2. . . . P to B6, 3. Kt to Kt3 (or Q6) ch, etc.

CORRECT SOLUTION received from J. Baddeley, who fails only in giving the correct attack in reply to P to Q7.

Six other solvers have attempted the problem, 1. Q to Q6 being the favourite beginning. This works very well against 1. . . . P × Kt, and even 1. . . . B to B4, but 1. . . . B to Ksq seems a valid defence. In fact, the amount of defensive work done by the Black Queen's Bishop in reply to many "tries," is a feature of the problem, which is probably one of the finest four-movers ever composed.

C. H. Schachel.—After 1. B to Kt6ch, K moves; 2. R × P, K to B5; 3. Q to R6ch, K × P, there is no mate. Probably also there are other defences at move 2.

W. H. Jones.—1. R × P seems all right if Black reply 1. . . . K to Q4 (as you give), or 1. . . . P × Kt. But is there a mate in 3 after 1. . . . K × R? We have no time to examine it.

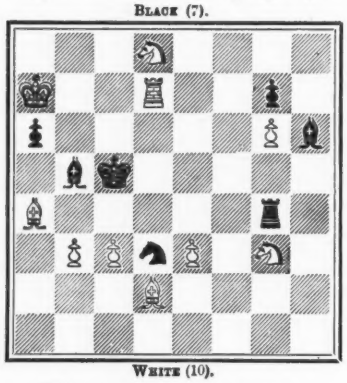
J. K. Macmeikan.—Many thanks for your problem, which appears below.

PROBLEMS.

No. 1.

By J. K. Macmeikan (Repton).

BLACK (7).

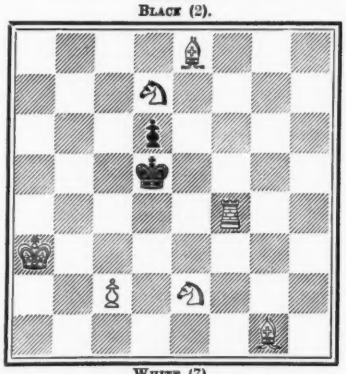


WHITE (10).

White mates in two moves.

No. 2.

BLACK (2).



WHITE (7).

White mates in two moves.

CHESS INTELLIGENCE.

There were twelve competitors in the Russian National Tournament, which was held recently in Moscow. M. Tchigorin won the first prize with the fine score of 10 out of a possible 11. M. Schiffers scored 7½, and took the second prize. The remainder of the competitors are probably unknown to English players.

In the tournament of the New York State Chess Association, Mr. Lipschütz has won the first prize, and proved clearly that his play has suffered no deterioration during his long retirement from the chess arena. The second prize resulted in a tie between Mr. Kemeny and Mr. F. J. Marshall, the winner of the "second tournament" in London last summer. Messrs. Halprin, Shipley and Bampton divided the fourth and fifth prizes.

KNOWLEDGE, PUBLISHED MONTHLY.

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Chess Column. By C. D. Locock, B.A.
PLATE.—Photographs of Clouds.

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PLATE.—Arctic Shrimp and Oriental River Prawn.

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